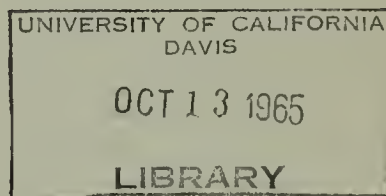


State of California  
THE RESOURCES AGENCY  
Department of Water Resources

BULLETIN No. 99-1

UPPER PUTAH CREEK BASIN INVESTIGATION  
DRY CREEK PROJECT

MAY 1965



HUGO FISHER  
*Administrator*  
The Resources Agency

EDMUND G. BROWN  
*Governor*  
State of California

WILLIAM E. WARNE  
*Director*  
Department of Water Resources







Approximate location and outline of the proposed Collayomi Dam and Reservoir

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## DEPARTMENT OF WATER RESOURCES

P. O. BOX 388  
SACRAMENTO



February 5, 1965

Honorable Edmund G. Brown, Governor  
and Members of the Legislature  
of the State of California

Gentlemen:

Bulletin No. 99-1, "Upper Putah Creek Basin Investigation, Dry Creek Project", was authorized under the Budget Acts of 1962 and 1963.

This bulletin indicates that construction of a water development project, consisting of a dam and reservoir on Dry Creek and a distribution system, is economically justified and financially feasible if federal assistance can be obtained. Water conserved in Collayomi Reservoir would be used to irrigate lands in Collayomi and Long Valleys, and provide a dependable domestic supply for the community of Middletown. In addition to supplying water for agricultural and urban use, the project would provide a limited opportunity for developing the recreation potential of the area. Due to the steep terrain, the major attraction and probably the major use would be from fishing in the reservoir.

The development proposed in this report would enhance the economy of Middletown and the surrounding area which has long been inhibited by a lack of an adequately developed water supply.

Sincerely yours,

A handwritten signature in dark ink, appearing to read "William E. Warne", is written over the typed name "Director".

Director

State of California  
The Resources Agency  
DEPARTMENT OF WATER RESOURCES

EDMUND G. BROWN, Governor  
HUGO FISHER, Administrator, The Resources Agency  
WILLIAM E. WARNE, Director, Department of Water Resources  
ALFRED R. GOLZE, Chief Engineer, Department of Water Resources

John M. Haley . . . . . Acting Assistant Chief Engineer

DELTA BRANCH

Carl A. Werner . . . . . Branch Chief  
M. Guy Fairchild . . . . . Chief, Planning Section

----O----

The investigation and preparation of this  
report was under the direction of

Robert F. Fingado . . . . . Senior Engineer, Water Resources  
  
and

Warren J. Cole . . . . . Senior Engineer, Water Resources

by

Wayne T. Haas . . . . . Assistant Civil Engineer  
Herbert M. Matsinger, Jr. . . . . Assistant Civil Engineer

Special assistance was contributed by

Robert R. McGill, Jr. . . . . Associate Land and Water Use Analyst  
George Curtin . . . . . Associate Engineering Geologist  
Dean R. Schnaible . . . . . Associate Engineering Geologist  
James L. Kuebelbeck . . . . . Assistant Economic Analyst  
C. Melvin Warner . . . . . Assistant Economic Analyst  
William C. Johnson . . . . . Recreation Planner II  
William M. Kier. . . . . Fisheries Biologist III

CALIFORNIA WATER COMMISSION

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NORRIS POULSON, La Jolla

MARION R. WALKER, Ventura

- - - 0 - - -

WILLIAM M. CARAH  
Executive Secretary

ORVILLE ABBOTT  
Engineer

## ACKNOWLEDGMENT

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State of California

Soil Conservation Service  
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of Agriculture

Lake County Flood Control and  
Water Conservation District

Middletown County Water District

## CHAPTER I

Summary and Conclusions

A study of the Dry Creek Project was authorized by the State Legislature in the Budget Acts of 1962 and 1963. The purpose or objective of the study was to determine the engineering, economic, and financial feasibility of a water development project to serve Collayomi Valley and Long Valley in Lake County. This bulletin is a report of that study.

The development and economic growth in Collayomi and Long Valleys has been inhibited due to the lack of an adequately developed water supply. Until an adequate supply can be developed at a price within the users' ability to pay, this inhibiting factor will continue to place a restraint on the area's development and economic growth rate. Local interests are aware of this situation. It was, in fact, largely through their efforts that studies for Department of Water Resources' Bulletin No. 99, "Reconnaissance Report on Upper Putah Creek Basin Investigation", issued March 1962, and this bulletin were authorized.

The area of investigation includes all of Collayomi and Long Valleys. These valleys are located in the southerly portion of Lake County and lie within the generally hilly and mountainous area east of the crest of the Coast Range. Middletown, an unincorporated community of about 450 residents, is the only town in the study area. It is situated at the junction of the two valleys.

Of the 16,400 acres included within the area of investigation, only about 1,600 acres are presently being used for agricultural purposes. Acreage of these developed lands is about evenly divided between dry-farmed and irrigated agriculture.

The service area lies within the area of investigation and contains approximately 5,700 acres. This area is considered to be representative of the one which would ultimately be supplied by the project. The service area was established so that it includes lands with suitable soil conditions which generally could be supplied by gravity flow from the reservoir.

The net project service area contains approximately 3,500 acres and represents the amount of land that will be irrigated with project water at full development. This area was established by reducing the service area by 460 acres of agricultural land presently receiving a full water supply and 1,740 acres of land projected for roads, canals, farmsteads, and urban use.

The Dry Creek Project will provide an adequate water supply to the urban population and presently dry-farmed lands within the service area. Full agricultural development is expected to take place in the net project service area by the 15th year following completion of project construction. After that time, it is anticipated that agricultural development will be sustained at the same level for 15 to 20 years and then show a decline due to urban encroachment on irrigated lands. Demand for project water will increase steadily throughout the 50-year repayment period, reaching a maximum of 6,600 acre-feet by the 50th year following project construction.

The population of Middletown is projected to reach about 3,500 by the year 2020. Although the amount of project water required for municipal use will be relatively small during the initial years, by the 50th year of project life urban use is expected to constitute a substantial portion of the total water demands.

The plan of development proposed in this report will, in addition to supplying supplemental water for agricultural and urban use, provide a limited opportunity for developing the recreation potential of the area. The major attraction, and probably the major recreation use, would be from fishing in Collayomi Reservoir. The extent to which this attraction is developed will dictate the amount of recreation benefits to be derived from the project.

A study was made, in cooperation with the Department of Fish and Game and the Department of Parks and Recreation, of the reservoir fishery potential under three alternative schemes of management. These alternatives were: (1) a warmwater fishery only, (2) a warmwater fishery plus an early season trout fishery, and (3) a warmwater fishery plus a prolonged summer trout fishery made possible by controlling the water temperature in the reservoir. Scheme number two was studied in some detail.

The local water agency responsible for the operation of the project should be the agency which selects the recreation and fishery management plan of development. Since it was not known which of the local agencies would construct and/or operate the project and to what degree the agency would be willing to assume responsibility for the operation of the recreation facilities, no specific recreation development was included as part of the project plan. In any event, the scheme of recreation development selected will have no effect on the overall project plan insofar as the development of a supplemental water supply for urban and agricultural use is concerned. The optimum reservoir storage capacity and the size of the distribution system will be the same regardless of the scheme chosen.

The Dry Creek Project will consist of two main features, a dam and reservoir on Dry Creek, and a water distribution system.

Collayomi Dam will be a 129-foot high earthfill structure at approximate streambed elevation 1,168 feet. The reservoir formed by the dam will have a gross storage capacity of 6,600 acre-feet.

The distribution system will consist of 27.5 miles of lined canals and pipelines for delivery of irrigation water to the farm headgates and domestic water to the Middletown water system.

The plan of development has been found to be economically justified and engineeringly and financially feasible.

Total project costs, including lands and rights-of-way, construction, engineering and administration, contingencies, interest during construction, but excluding recreation costs, are estimated to be \$3,360,000. Of this, the dam and reservoir is estimated to cost \$2,472,000, and the distribution system \$888,000.

The net average annual benefits accruing to the project, excluding recreation benefits, were estimated to be \$233,600. Average annual equivalent project costs, including operation and maintenance costs, were estimated to be \$143,000. The resulting ratio of benefits to costs is 1.6:1. A general summary of the project follows.

At the request of local interests, <sup>1/</sup> the economic and financial analyses of the Dry Creek Project were prepared in accordance with requirements for financing under the "Watershed Protection and Flood Prevention Act", Public Law 83-566, <sup>2/</sup>as amended. Under the provisions of Public Law 83-566, the Federal Government is authorized to share certain project

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<sup>1/</sup> Resolution No. 64-B.F.C., Appendix A.  
<sup>2/</sup> 68 Stat. 566; 16 U.S.C. Secs. 1001-1009.

costs with the project beneficiaries. Project costs designated as "Federal Costs" are nonreimbursable. The remainder of the necessary financing can be obtained from the U. S. Farmers Home Administration in form of a loan repayable within 50 years at the current federal interest rate of 3 percent. An equivalent water charge of \$14.25 per acre-foot for irrigation water and \$40.00 per acre-foot for domestic water would be required to repay the reimbursable portion of the costs.

Construction of the Dry Creek Project as part of the federal Central Valley Project is also a possibility. The U. S. Bureau of Reclamation intends to include a recommendation for the construction of a project to serve Middletown and the surrounding valleys as a feature of the West Sacramento Valley Canal Unit. This will require an exchange agreement with the Solano Project. A report by the Bureau will be submitted to the Congress in the spring of 1965 seeking authorization and appropriations for extension of the West Sacramento Valley Canal Unit.

## GENERAL SUMMARY OF THE DRY CREEK PROJECT

Physical FeaturesDam and Appurtenant Works

|   |                                       |           |
|---|---------------------------------------|-----------|
| Location . . . . .                        | on Dry Creek 500 feet below USGS gage |           |
| Type . . . . .                            | Earthfill                             |           |
| Crest elevation, in feet . . . . .        |                                       | 1,297     |
| Height above streambed, in feet . . . . . |                                       | 129       |
| Streambed elevation, in feet . . . . .    |                                       | 1,168     |
| Crest length, in feet . . . . .           |                                       | 1,285     |
| Crest width, in feet . . . . .            |                                       | 20        |
| Upstream slope . . . . .                  |                                       | 3.0:1     |
| Downstream slope . . . . .                |                                       | 2.5:1     |
| Volume of fill, in cubic yards . . . . .  |                                       | 1,225,000 |
| Type of spillway . . . . .                | Ungated ogee weir                     |           |
| Type of outlet works . . . . .            | Cut and cover                         |           |

Reservoir

|   |       |
|---|-------|
| Normal pool elevation, in feet . . . . .        | 1,282 |
| Minimum pool elevation, in feet . . . . .       | 1,216 |
| Surface area at normal pool, in acres . . . . . | 151   |
| Total storage capacity, in acre-feet . . . . .  | 6,600 |
| Active storage capacity, in acre-feet . . . . . | 6,000 |
| Drainage area, in square miles . . . . .        | 8.4   |

Distribution System

|   |      |
|---|------|
| Concrete-lined canals, in miles . . . . . | 15.0 |
| Pipelines, in miles . . . . .             | 12.5 |
| Fencing, in miles . . . . .               | 1.3  |

Benefits and Costs

|  |             |
|--|-------------|
| Total project cost . . . . .                     | \$3,360,000 |
| Net annual project benefits . . . . .            | \$ 233,600  |
| Average annual equivalent project cost . . . . . | \$ 143,000  |
| Ratio, benefits to cost . . . . .                | 1.6:1       |

Recommendations

It is recommended that:

1. Lake County agencies continue to press for early development of the Dry Creek Project, either by the Soil Conservation Service under Public Law 83-566, or by the U. S. Bureau of Reclamation as a part of the Central Valley Project.
2. Lake County agencies continue to appear and state their interest and position at all hearings affecting the water rights in the Upper Putah Creek Basin.
3. Local agencies take the necessary steps to assure that the quality of project water will be suitable for municipal water supply purposes.
4. If the Dry Creek Project is formulated under Public Law 83-566, then:
  - a. The project be constructed substantially in accordance with the plan of development outlined in this report.
  - b. A local water district be selected as the sponsoring agency for the construction and operation of the project. This agency should be one of the existing agencies in the area having the legal and financial ability to carry out the necessary steps for project construction and operation.
  - c. The local sponsoring agency continue to work closely with representatives of the U. S. Soil Conservation Service toward completion of the conditional requirements for a loan under Public Law 83-566.
  - d. The local sponsoring agency continue to meet with all appropriate agencies, including the State Department of Fish and Game, State Department of Water Resources, U. S. Fish and Wildlife Service, U. S. Bureau of Reclamation, U. S. Farmers Home Administration, and other relevant agencies, to complete formulation and financing arrangements for the project.

- e. The local sponsoring agency work with the local soil conservation district and other appropriate agencies to study possible plans for recreation development to be combined as part of the project.
- f. If recreation is included as a project purpose, inquiries be made of the Department of Water Resources concerning the possibility of obtaining assistance under the Davis-Grunsky Act.
- g. A municipal water district, or similar agency, be established to serve as the contracting agency for purchase of project water for Middletown from the local sponsoring agency.

## CHAPTER II

Purpose and Scope

The Department of Water Resources was authorized by the Legislature in the Budget Acts of 1962 and 1963 to conduct a two-year feasibility study of the Dry Creek Project. The objective of the study, as stated in the Budget Acts, was to determine the engineering, economical, and financial feasibility of a water development project to serve Collayomi Valley and Long Valley in Lake County.

This bulletin describes the feasibility study of the Dry Creek Project which would consist of an earthfill dam on Dry Creek near Middletown, and a water distribution system. The project was formulated to provide: (1) a dependable water supply for present and future agricultural needs; (2) a dependable domestic water supply for the community of Middletown; and (3) an opportunity for the development of reservoir-associated recreation use compatible with other project functions. The plan of development was formulated to maximize the net benefits of the combined project functions.

Flood control facilities were not included as a feature of the Dry Creek Project. Since Middletown is located near the confluence of Dry Creek and St. Helena Creek with Putah Creek, adequate protection cannot be provided unless all three creeks are subject to a suitable degree of control. Therefore, the project will provide only incidental flood protection.

The State Water Rights Board Decision No. D869, issued February 7, 1957, places a time limitation on the right to develop the water resources in the Upper Putah Creek Basin. This decision on the U. S. Bureau of

Reclamation's application to appropriate water from Putah Creek for the Solano Project, provides for the reservation of a water supply for the Putah Creek Basin above Monticello Dam, provided that the development and beneficial use of this water occurs prior to the time it is put to beneficial use in the Solano Project service area. Once a portion of the flow of Putah Creek is appropriated for use in the Solano Project service area, the right to this supply will be lost for use in the upper basin. A need exists, therefore, for early development of the water supply of Dry Creek, if the right to this natural resource is to be protected.

#### Location of Study Area

Collayomi and Long Valleys are located in the southerly portion of Lake County. The area lies in the generally hilly and mountainous part of the northern California Coast Range. Middletown, an unincorporated community of about 450 residents, lies at the junction of these two valleys.

The area under investigation includes all of Collayomi Valley and Long Valley and totals about 16,400 acres. Plate No. 1, "Location of Area of Investigation", shows the general location of the study area in the State and Lake County.

#### Physical Characteristics of Study Area

The climate of Collayomi and Long Valleys is of the mild two-season pattern. A warm, dry season extends from May through September, with a cool, wet season occurring from October through April. Mean seasonal precipitation varies from an average of about 42 inches in the valleys

to over 80 inches at the Helen Mine in the Mayacmas Mountain Range to the west. Rainfall constitutes practically all the precipitation in the area. Snowfall is rare, except at the higher elevations, and does not have a significant effect on the hydrologic characteristics of stream-flow. Over 95 percent of the precipitation occurs during the period from October through April. The growing season is relatively long, there being approximately 250 days between killing frosts.

Both Collayomi and Long Valleys contain extensive level valley lands. Little land leveling or other preparatory work would be required to prepare the major part of the land for gravity or sprinkler irrigation. The climate, topography, soil conditions, and location of the project service area are considered ideally suited for the production of high-acid wine grapes. The wine industry in California is seeking lands to replace those taken out of production by urban encroachment. The Napa Valley wine industry has built up over the years an image of quality wine products associated with the words "Napa Valley". Advantage is being taken of this image by importing grapes grown sufficiently close to Napa Valley to allow the advertisement of their being produced in the Napa area. Therefore, the location of Collayomi and Long Valleys, together with their suitability for wine grape production, will probably lead to an increased use of the land for vineyards when an adequate water supply becomes available. In addition to the production of high-acid wine grapes, the area is considered suitable for deciduous orchards and the production of walnuts, miscellaneous truck crops, alfalfa, and pasture.

History of Area

A small village functioning as a trading post and stagecoach stop had developed at Guenoc in Coyote Valley as early as 1860. In 1866, the State Legislature granted a toll road franchise beginning at Calistoga in Napa Valley and terminating at the present site of Middletown. Middletown was established in 1871 when the small settlement at Guenoc was moved to the present Middletown site.

Middletown, along with Lake County in general, developed slowly until the 1870's when it became fashionable to visit the mineral spring resorts (spas) in the area. Visitors to these resort areas used the Calistoga-Lower Lake Road, and Middletown, which lies along this route, gained some recognition as a travel stop.

In addition to this function, the town began to gain importance as a trading area for the cinnabar (quicksilver) mines located in the surrounding mountains. The town reached its maximum development in 1895 when mining in the surrounding area was at its peak. At that time, the Great Western Mine employed 250 miners, and these, in addition to those employed at other mines in the area, provided a market for goods and services in Middletown.

Agriculture has developed slowly in Collayomi and Long Valleys. No substantial buildup occurred in the early years, although in the early 1880's sheep were grazed in the two valleys. Present agricultural development consists of about 800 acres of dry-farmed land and about 800 acres of irrigated pasture and miscellaneous field crops.

The mining industry, which played an important role in stimulating the economic growth of the area in the past, no longer has a



Aerial view of Middletown. St. Helena Creek in foreground. Confluence of Dry Creek with Putah Creek shown in left center of photograph. Note that the three creeks nearly encircle Middletown.

significant effect on the economy. The dependence has shifted to agriculture and agricultural development has been limited by lack of an adequately developed water supply.

Most of the present water supply for irrigation and domestic use is derived from ground water. Over 100 wells have been drilled in Collayomi and Long Valleys. However, ground water has proven unreliable from a standpoint of both quality and quantity, and the local people are reluctant to risk additional capital for this type of water development.

Some direct surface irrigation occurs along Putah Creek in the northern portion of Collayomi Valley, and along St. Helena Creek in the southern part of Collayomi Valley. The hydrologic characteristics of these streams limit the potential use of surface diversions for irrigation as the runoff during the irrigation season is too small to support any significant amount of agricultural development.

The high cost and risk involved in ground water development and the unfavorable hydrologic characteristics of streamflow during the irrigation season has handicapped the economic growth of the area.

#### Related Studies and Investigations

During this study, the many different reports which dealt with the water development problems of Collayomi and Long Valleys were reviewed. Particular emphasis was given to the review of information developed for Bulletin No. 99, "Reconnaissance Report on Upper Putah Creek Basin Investigation", issued by the Department of Water Resources in March 1962. Information in Bulletin No. 99, along with basic data in the Department's files, formed the basis on which much of the detailed studies contained in this report were made. Reports and other sources of information reviewed and used are listed in Appendix L, "Bibliography".

Local Interest in Water Development

There has been considerable interest shown at both a local and county-wide level in the development of a supplemental water supply for the Collayomi-Long Valley area. The Board of Supervisors of Lake County have been very active in the promotion of water development projects within the county. It was largely due to their efforts that the studies for Bulletin No. 99 and this bulletin were authorized by the Legislature.

Specific interest has been expressed by the Board of Supervisors in developing a reservoir on Dry Creek. In 1958, the firm of George S. Nolte, Consulting Civil Engineers, Inc. was engaged to determine the reasonableness of preparing a complete feasibility report of a water development project on Dry Creek in accordance with the requirements of the Small Reclamation Project Act, Public Law 84-984 <sup>1/</sup>, as amended. About the same time, an agreement was reached with the U. S. Bureau of Reclamation to conduct a land classification and land use survey in the proposed Dry Creek Project service area. The Nolte study concluded that such a project would be economically feasible. Local interests, however, deferred action on the project until results of the reconnaissance investigation (Bulletin No. 99) were known, to determine whether alternate projects might be more advantageous.

Following the publication of Bulletin No. 99, joint public hearings were held in July 1962 by the Department of Water Resources and the California Water Commission to receive comments and statements from agencies, groups, and individuals on the conclusions reached in the bulletin. The Lake County Flood Control and Water Conservation District presented a statement <sup>2/</sup> at the hearing endorsing the conclusions reached in the bulletin concerning the Dry Creek Project, and requested that the Department of Water Resources continue investigating the feasibility of constructing a project on Dry

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<sup>1/</sup> 70 Stat. 1044.

<sup>2/</sup> Statement of Lake County Flood Control and Water Conservation District, Appendix A.

Creek. Authorization was granted to the Department to continue studies on the Dry Creek Project by the Legislature in the 1962-63 session.

During the present investigation, officials of local water agencies have frequently met with Department personnel to discuss the progress of the studies and to offer assistance whenever possible.

#### Local Water Districts

At the present time, there are four water districts in Collayomi Valley and Long Valley which have the legal powers necessary to deal with the water problems of the area. The name, date formed, and current status of the districts are summarized below:

| Name   | : Date : | Status   |
|--|----------|----------|
| 1. Lake County Flood Control and Water Conservation District | 1951     | Active   |
| 2. Middletown County Water District                          | 1959     | Active   |
| 3. East Lake Soil Conservation District <u>1/</u>            | 1961     | Active   |
| 4. Middletown County Waterworks District No. 5               | 1947     | Inactive |

1/ This district was formed by combining the Lower Lake Soil Conservation District and the Middletown Soil Conservation District.

Additional information on these districts including the laws under which they were established is given in Part A of Appendix B, "General Information on Existing Local Districts". A synopsis of their rights and duties is presented in Part B of Appendix B, "Synopsis of Rights and Duties of Local Water Districts".

## CHAPTER III

Water Supply

The water resources of Collayomi Valley and Long Valley were discussed in Bulletin No. 99. The conclusions reached in that report were: (1) the water resources available for development were adequate to meet the needs of the area, and (2) an adequate water supply could be developed at a cost suitable for irrigated agricultural development. The report recommended that the runoff originating in the Dry Creek Drainage Basin be considered as the primary source of supply for Collayomi and Long Valleys in future studies. Ground water development was also recommended as a potential source for supplying all or part of the water needs of the area.

Surface Water Supply

Runoff available for storage in Collayomi Reservoir is derived from precipitation on the 8.4 square miles of drainage basin above the damsite. Precipitation occurs primarily in the form of rain, although there are insignificant amounts of snowfall at the higher elevations. Heavy brush and wooded lands cover most of the watershed.

A standard method for determining the water supply available to a project during a typical 50-year repayment period is to assume that the water supply will equal the supply available from runoff in the past. The sequence of flows occurring during the 1906 through 1955 period was selected as the project water supply for analysis purposes.

A stream gaging station was installed on Dry Creek at the approximate location of the proposed Collayomi Dam in May 1959. There are no

records of the flow in Dry Creek prior to that time. To extend the record of flow to cover the 1906 through 1955 period, the runoff of Dry Creek was correlated with the flow of Putah Creek near Guenoc.

The estimated flow of Dry Creek by months for the period 1906 through 1959 had been derived as part of the basic data studies for Bulletin No. 99. Since additional hydrologic data were available, flow estimates computed for Bulletin No. 99 were checked for a 20-year period, 1919 through 1940. This 20-year period was selected for a check of the flow estimates since it covers the years of most adverse historical conditions of water supply.

The method used to estimate flows in Dry Creek for this 20-year period is as follows. A good correlation was found to exist between the recorded flows of Dry Creek and Putah Creek near Guenoc for their common period of record when the flow of Putah Creek exceeded 750 acre-feet per month. Figure 1 was developed to estimate the flow in Dry Creek when the flow in Putah Creek exceeded 750 acre-feet per month.

Although the gaging station on Putah Creek at Guenoc was not established until July 1930, estimates of natural flow for the period 1906 to July 1930 had been developed as part of the basic data studies for Bulletin No. 99. This flow record was used in computing the Dry Creek flow estimates from Figure 1.

When the flow of Putah Creek near Guenoc was less than 750 acre-feet per month, the flow in Dry Creek was estimated as follows. A runoff-recession curve was developed for Dry Creek based on the recorded flows. This curve is shown as Figure 2. Low flows in Dry Creek were first estimated using Figure 2 and then adjusted if precipitation records at stations in and adjacent to the basin indicated further adjustment of low flows were

necessary. Inasmuch as the estimated mean seasonal runoff at Dry Creek near Middletown is about 21,000 acre-feet annually, and it was contemplated that active reservoir storage would be less than half this amount, refinement of seasonal runoff estimates for years of high flows was not deemed necessary.

The flows for the 20-year period, as computed for this investigation, were found to be in close agreement with the estimates of flow derived for Bulletin No. 99. Because of this close agreement, monthly estimates of flow are from Bulletin No. 99 studies except for the 20-year period that was recomputed as described above.

The estimated average seasonal runoff of Dry Creek for the 50-year period is 21,000 acre-feet. The seasonal runoff varied from a high of 53,800 acre-feet in 1937-38 to a low of 4,000 acre-feet in 1930-31. A summary of the estimated runoff of Dry Creek by months for the 50-year period 1906 through 1955 is given in Table 1.

#### Ground Water Supply

Considerable discussion of the Collayomi-Long Valley ground water basin is presented in Bulletin No. 99. Studies of the area indicated that no well-defined aquifer of any great areal extent lies within the basin. Rather, the aquifer was found to exist as a series of confined, semiconfined, and unconfined layers of permeable and semipermeable materials which are partially merged and interconnected.

The major source of ground water recharge to the basin is from percolation of streamflow in Putah Creek, St. Helena Creek, and Dry Creek. Most of the major existing irrigation wells are located in Collayomi Valley along Putah Creek. During dry years and late summer months, when the flow

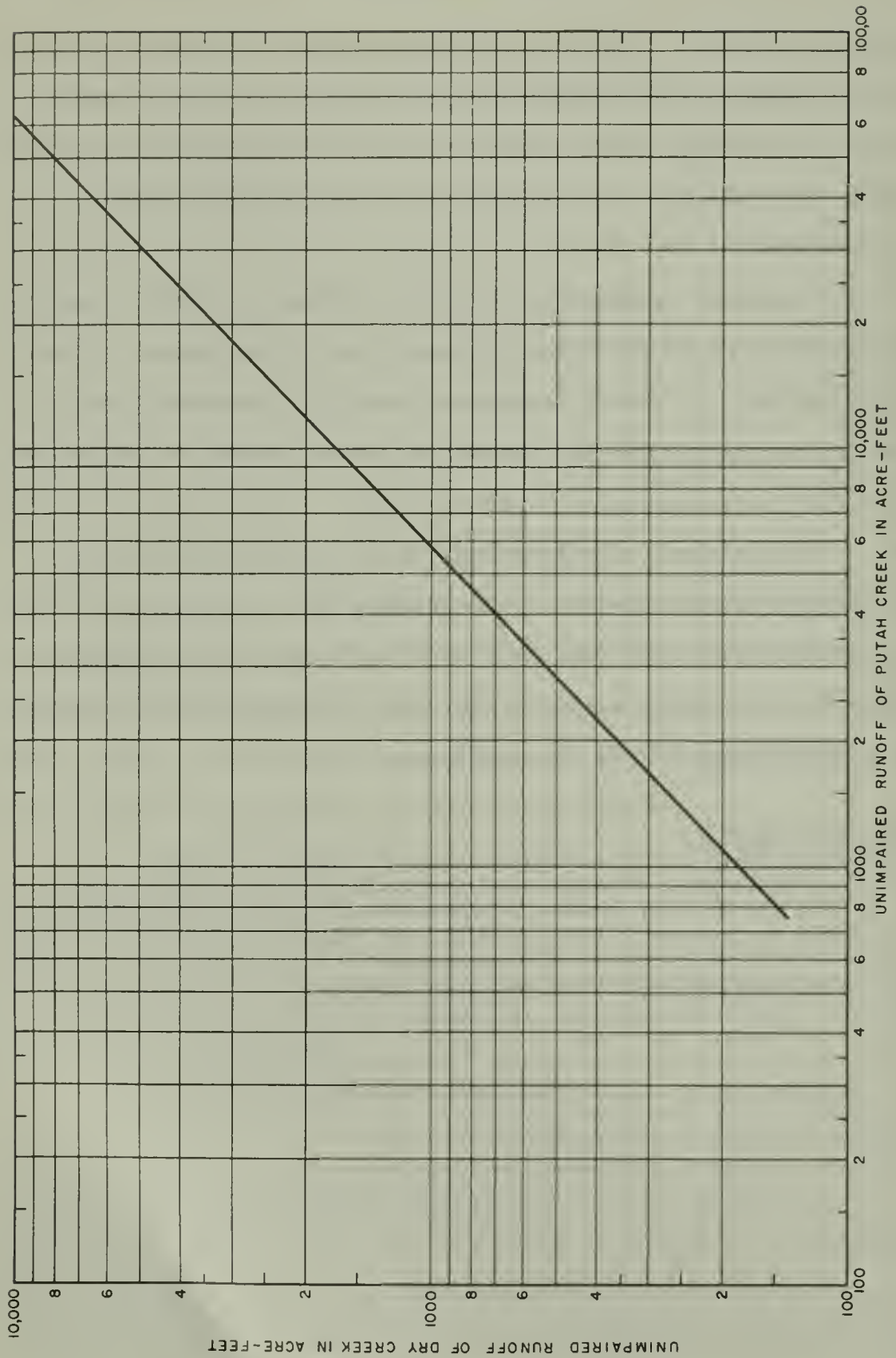


Figure 1. MONTHLY RUNOFF CORRELATION CURVE FOR  
DRY CREEK NEAR MIDDLETOWN AND PUTAH CREEK AT GUENOC

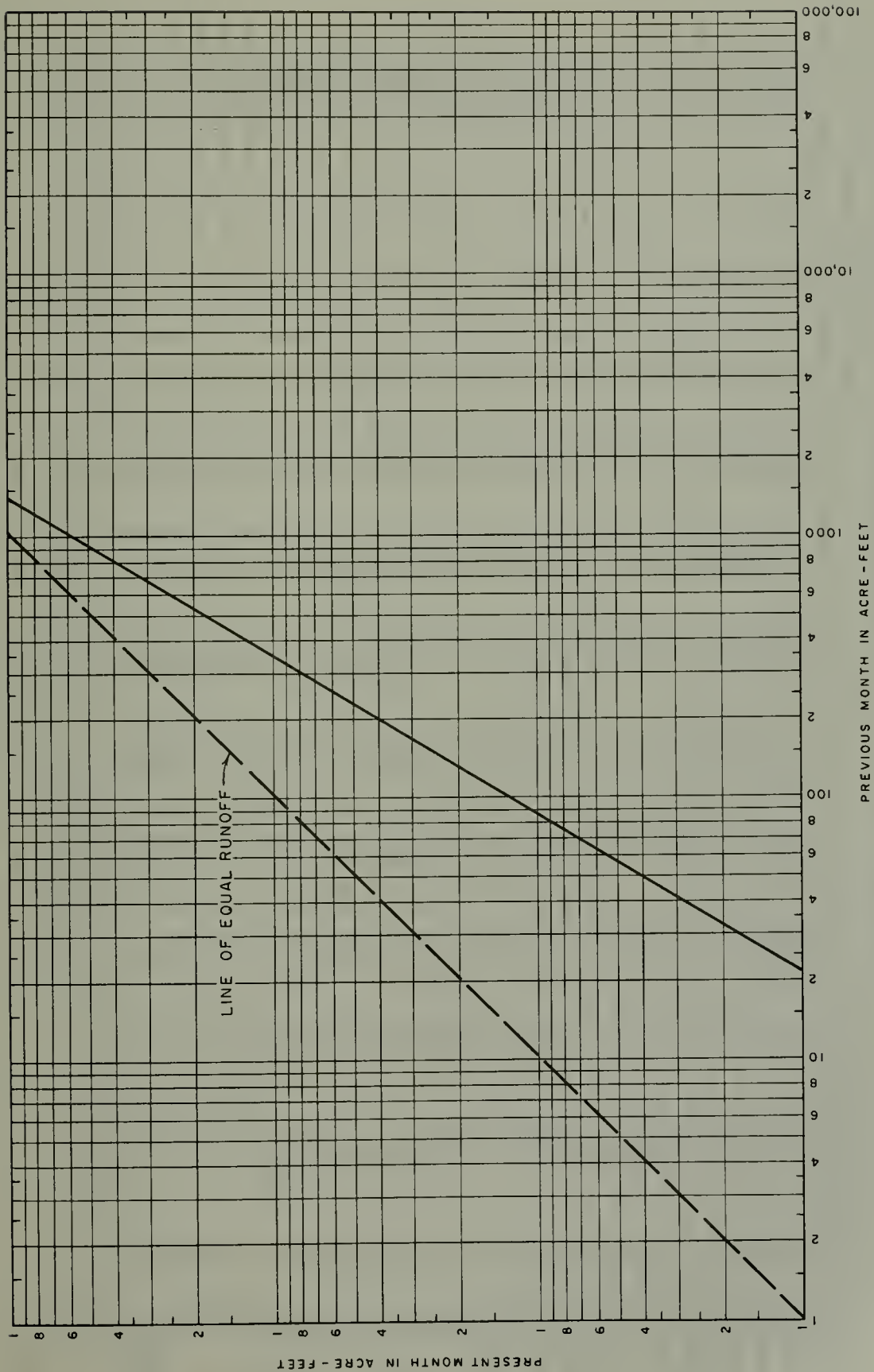


Figure 2. NORMAL MONTHLY RECESSION CURVE FOR DRY CREEK NEAR MIDDLETOWN

TABLE 1

## UNIMPAIRED FLOW OF DRY CREEK NEAR MIDDLETOWN

Source of Record

Computed

Unit Acre-feet Area 8.41 Sq. Mi.

| SEASON  | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH  | APRIL  | MAY   | JUNE  | JULY | AUGUST | SEPTEMBER | TOTAL  |
|---------|---------|----------|----------|---------|----------|--------|--------|-------|-------|------|--------|-----------|--------|
| 1905-06 |         |          |          | 17,500  | 6,400    | 8,600  | 3,000  | 2,200 | 1,700 | 310  | 130    | 100       | 39,940 |
| 07      | 50      | 120      | 2,650    | 7,800   | 5,800    | 16,500 | 35,000 | 900   | 420   | 180  | 40     | 30        | 37,990 |
| 08      | 120     | 130      | 1,150    | 3,900   | 6,000    | 3,400  | 700    | 380   | 180   | 20   | 10     | 0         | 15,990 |
| 09      | 0       | 30       | 500      | 22,000  | 15,300   | 4,000  | 1,500  | 520   | 270   | 60   | 20     | 10        | 44,210 |
| 1909-10 | 100     | 300      | 3,400    | 5,100   | 2,700    | 3,600  | 1,450  | 480   | 140   | 40   | 10     | 0         | 17,320 |
| 11      | 0       | 50       | 120      | 8,800   | 5,100    | 12,400 | 2,100  | 800   | 230   | 60   | 20     | 0         | 29,680 |
| 12      | 100     | 120      | 170      | 1,500   | 450      | 2,400  | 620    | 700   | 140   | 40   | 10     | 0         | 6,250  |
| 13      | 60      | 770      | 550      | 7,250   | 820      | 800    | 760    | 230   | 40    | 20   | 0      | 0         | 11,300 |
| 14      | 0       | 400      | 8,300    | 23,000  | 8,600    | 2,600  | 1,500  | 600   | 230   | 60   | 20     | 0         | 45,310 |
| 1914-15 | 40      | 30       | 600      | 6,400   | 19,500   | 6,000  | 2,500  | 2,500 | 620   | 220  | 100    | 40        | 38,550 |
| 16      | 60      | 80       | 4,700    | 21,000  | 5,900    | 4,000  | 1,100  | 600   | 300   | 60   | 20     | 20        | 37,840 |
| 17      | 80      | 90       | 2,150    | 1,900   | 11,200   | 2,600  | 1,300  | 530   | 160   | 70   | 10     | 10        | 20,100 |
| 18      | 40      | 60       | 140      | 160     | 3,400    | 3,600  | 900    | 250   | 80    | 40   | 20     | 0         | 8,690  |
| 1918-19 | 20      | 50       | 150      | 2,040   | 13,620   | 5,200  | 790    | 340   | 100   | 10   | 0      | 0         | 22,320 |
| 20      | 20      | 50       | 220      | 150     | 130      | 1,160  | 2,650  | 460   | 170   | 30   | 0      | 210       | 5,250  |
| 21      | 0       | 4,040    | 7,500    | 14,160  | 3,470    | 1,850  | 770    | 360   | 150   | 20   | 0      | 0         | 32,320 |
| 22      | 10      | 120      | 2,730    | 730     | 9,880    | 2,820  | 1,220  | 290   | 80    | 10   | 0      | 0         | 17,890 |
| 1922-23 | 170     | 1,050    | 10,100   | 4,090   | 1,860    | 770    | 2,390  | 410   | 150   | 20   | 0      | 20        | 21,030 |
| 24      | 0       | 10       | 90       | 500     | 3,360    | 410    | 140    | 20    | 0     | 0    | 0      | 0         | 4,530  |
| 25      | 440     | 630      | 1,960    | 870     | 14,400   | 2,040  | 2,290  | 1,680 | 530   | 200  | 40     | 10        | 25,090 |
| 26      | 0       | 150      | 190      | 2,630   | 11,350   | 1,100  | 8,260  | 600   | 170   | 30   | 0      | 0         | 24,480 |
| 27      | 40      | 4,010    | 2,500    | 3,720   | 14,000   | 2,530  | 6,100  | 650   | 270   | 70   | 10     | 0         | 33,900 |
| 1927-28 | 20      | 8,500    | 1,880    | 2,160   | 4,810    | 7,060  | 3,500  | 580   | 150   | 20   | 0      | 0         | 28,680 |
| 29      | 0       | 170      | 1,420    | 700     | 3,240    | 1,040  | 460    | 240   | 80    | 10   | 0      | 0         | 7,360  |
| 30      | 0       | 0        | 7,920    | 5,440   | 3,880    | 4,510  | 850    | 410   | 150   | 20   | 0      | 0         | 23,180 |
| 31      | 10      | 60       | 50       | 1,750   | 500      | 1,200  | 290    | 90    | 50    | 0    | 0      | 0         | 4,000  |
| 32      | 60      | 0        | 7,020    | 2,840   | 2,090    | 630    | 430    | 450   | 210   | 40   | 0      | 0         | 13,770 |
| 1932-33 | 0       | 0        | 190      | 3,050   | 1,180    | 2,650  | 850    | 560   | 150   | 30   | 0      | 0         | 8,660  |
| 34      | 0       | 0        | 4,520    | 2,500   | 3,660    | 1,430  | 490    | 230   | 50    | 10   | 0      | 0         | 12,890 |
| 35      | 0       | 780      | 540      | 8,040   | 1,860    | 6,350  | 4,550  | 750   | 190   | 40   | 0      | 0         | 23,100 |
| 36      | 0       | 0        | 0        | 6,270   | 14,190   | 1,790  | 2,190  | 440   | 300   | 80   | 10     | 0         | 25,270 |
| 37      | 0       | 0        | 0        | 610     | 9,400    | 5,420  | 1,520  | 480   | 260   | 60   | 10     | 0         | 17,760 |
| 1937-38 | 0       | 3,050    | 12,250   | 3,670   | 18,010   | 12,930 | 2,730  | 800   | 270   | 70   | 10     | 0         | 53,790 |



in Putah Creek is low, yields from these wells show a marked reduction. In Long Valley, recharge of the ground water basin is limited due to the presence of shallow, tight soils and the absence of a permanent stream. Wells in Long Valley are, for the most part, limited to domestic and stockwatering purposes.

Further ground water development in Long Valley and Collayomi Valley is hindered by two major factors: (1) locations of the water-bearing lenses and channels underlying the valley are not known, making it difficult to know where to drill the wells, and (2) wells drilled in the past have often proved to be inadequate for irrigation purposes because of poor water quality or low yield.

Since the cost and risk involved in the development of ground water in the basin are high, there is a reluctance among the local people to invest money in the construction of wells. Accordingly, project formulation as it relates to ground water was based on the following assumptions:

1. Lands presently being fully irrigated from ground water, or an equivalent acreage, will continue to utilize this source of water under project conditions.
2. No new ground water development of any significant extent will occur during the next 50 years if an adequate surface water supply is provided at a cost suitable for agricultural development.

#### Water Quality

Water quality may be defined as the characteristics of water affecting its suitability for beneficial use. The investigation of water quality in this report was limited to surface runoff originating in the 8.4 square miles of drainage basin above the proposed damsite. Since ground

water development is not a part of the Dry Creek Project, no additional study was made of the quality of this source.

Several abandoned mercury mines are located in the Dry Creek Drainage Basin. Drainage from the abandoned mines and water percolating through the mine tailings into Dry Creek or its tributaries, are the major potential sources of water quality impairment. To check these potential sources of pollution, a sample of mine drainage was obtained and analyzed. In addition, two samples were taken of the water in Dry Creek during a period of low flow when the runoff consisted primarily of spring and seepage flows, and possibly some drainage from the abandoned mercury mines located within the drainage basin. An analysis of the samples indicated that the mineral quality of the water is excellent and suitable for irrigation and domestic use.

The mineral analyses of the three surface water samples taken in the Dry Creek Drainage Basin above the proposed damsite are given in Table 2. Sample No. 1 was obtained from Dry Creek in Section 1, T10N, R8W, MDB&M, approximately 4 air miles west of Middletown. Sample No. 2 was also obtained from Dry Creek about 1,200 feet upstream from the USGS stream gaging station. Sample No. 3 was taken from mine drainage at the Wall Street Mine.

Although no water quality problem exists now, with the completion of Collayomi Dam and Reservoir other sources of water pollution may develop, particularly if recreation development takes place adjacent to the reservoir. Since the reservoir will be used as a source of water supply for domestic use, future project activities which may affect the quality of the water should be carefully studied. Criteria commonly used by the Department in evaluating

TABLE 2  
MINERAL ANALYSES OF SURFACE WATER SAMPLES  
IN THE  
DRY CREEK DRAINAGE BASIN

| Sample number | Date of sample | pH  | Specific conductance (micro-mhos at 25°C) | Mineral constituents, in parts per million |                |             |               |                            |                                 |               |                            |                            |              | Mineral constituents in parts per million |                            |    | Total hardness (CaCO <sub>3</sub> ) |
|---------------|----------------|-----|---|--|----------------|-------------|---------------|----------------------------|---------------------------------|---------------|----------------------------|----------------------------|--------------|---|----------------------------|----|-------------------------------------|
|               |                |     |   | Calcium (Ca)                               | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Sulfate (SO <sub>4</sub> ) | Bicarbonate (HCO <sub>3</sub> ) | Chloride (Cl) | Sulfate (SO <sub>4</sub> ) | Nitrate (NO <sub>3</sub> ) | Fluoride (F) | Boron (B)                                 | Silica (SiO <sub>2</sub> ) |    |                                     |
| 1             | 1/22/63        | 8.4 | 548                                       | 12<br>0.60                                 | 64<br>5.31     | 3.2<br>0.14 | 0.3<br>0.01   | 4<br>0.13                  | 276<br>4.52                     | 3.3<br>0.09   | 58<br>1.21                 | 0.2<br>0.00                | 0.2<br>0.00  | 0.10                                      | 0.11                       | 18 | 296                                 |
| 2             | 1/22/63        | 8.5 | 598                                       | 11<br>0.55                                 | 78<br>6.42     | 2.8<br>0.12 | 0.4<br>0.01   | 12<br>0.40                 | 340<br>5.57                     | 11<br>0.31    | 35<br>0.73                 | 0.2<br>0.00                | 0.2<br>0.00  | 0.10                                      | 0.27                       | 18 | 349                                 |
| 3             | 1/22/63        | 8.3 | 354                                       | 9.9<br>0.49                                | 40<br>3.31     | 3.6<br>0.16 | 0.5<br>0.01   | 0<br>0.00                  | 218<br>3.57                     | 2.4<br>0.07   | 11<br>0.23                 | 0.4<br>0.01                | 0.4<br>0.01  | 0.10                                      | 0.33                       | 21 | 190                                 |

water quality relative to its anticipated beneficial use is given in Appendix C, "Water Quality Criteria for the Dry Creek Project".

### Water Rights

An important prerequisite to any water development project is the acquisition of the necessary rights to divert, store, and use the quantities of water necessary for the successful operation of the project. The initial step in obtaining a right to appropriate water from a stream involves the filing of an application with the State Water Rights Board. The procedure for filing an application is contained in Part 2, Division 2, of the California Water Code.

Application No. 18165, dated May 29, 1958, was filed by Zone 2 of the Lake County Flood Control and Water Conservation District for the storage of Dry Creek water in the amount of 7,000 acre-feet annually. This application on which Permit No. 11751 has been issued, was assigned to the Middletown County Water District in 1959.

Water problems in the Upper Putah Creek Basin involve physical, economic, and legal factors. The foremost problem concerning water development in the area, as discussed in Bulletin No. 99 "Reconnaissance Report on Upper Putah Creek Basin Investigation" dated March 1962, has been that of available time to appropriate and develop additional water supplies to meet future needs. State Water Rights Board Decision No. D 869, dated February 7, 1957, granted permits to the U. S. Bureau of Reclamation to appropriate water from Putah Creek below Lake Berryessa to serve the Solano Project. Item 14 of such decision provided as follows:

"14. The permits and all rights acquired or to be acquired thereunder are and shall remain subject to depletion of stream flow above Monticello Reservoir not to exceed 33,000 acre-feet of water annually, by future appropriations of water for reasonable beneficial use within the watershed of Putah Creek above said reservoir; provided such future appropriations shall be initiated and consummated pursuant to law prior to full beneficial use of water within the project service area under these permits".

A more recent decision by the State Water Rights Board, Decision No. D 1131, adopted May 22, 1963, concerning an application of the U. S. Bureau of Reclamation to appropriate water from Lake Berryessa to serve existing and contemplated domestic and recreation development around the lake, is also significant in establishing the criteria to be used in determining the amount of depletion that would result from a new appropriation.

The Bureau contended that the gross diversion should be considered as a "direct writeoff" against the 33,000 acre-foot reservation. Thus, the 33,000 acre-foot reservation for upstream appropriations would be reduced by the total amount of the diversion sought in the application. Lake County protested this interpretation and contended that the reduction should be chargeable on a consumptive use or net depletion basis. The State Water Rights Board concurred with the position of Lake County.

A joint study to determine the actual depletion of the water supply to Lake Berryessa is now being made by the State Water Rights Board and the U. S. Bureau of Reclamation. The study, which is expected to be completed shortly, will help clarify the unappropriated water supply situation in the Upper Putah Creek Basin.

The right to store up to 7,000 acre-feet annually of Dry Creek water for use in supplying water needs in Collayomi Valley and Long Valley

is dependent upon the findings of the State Water Rights Board. It was assumed, as part of this study, that the necessary water rights will be granted. The final decision, however, rests with the State Water Rights Board and a decision on this most important matter should be requested prior to the initiation of any additional detailed study of the Dry Creek Project.



Collayomi Valley looking north. Dry Creek is shown in the foreground and Dry Creek Cutoff Road is in the center of the photograph.

## CHAPTER IV

General

The economy of Collayomi Valley and Long Valley is now dependent primarily upon agriculture. However, development of the agricultural potential has been inhibited by the lack of an adequately developed water supply. Decision No. D 869 of the State Water Rights Board, in its placement of a time limitation on the right to develop the water resources in the Upper Putah Creek Basin above Lake Berryessa, brought to a head the need for an orderly program of local water development.

An adequate supplemental water supply can be made available for local use in the Collayomi-Long Valley area by construction of a dam and reservoir on Dry Creek to store surplus winter runoff. The procedures used to determine the amount of water that should be developed to supply present and future water needs anticipated during the 50-year period following project construction are outlined in this chapter. A more detailed explanation is given in Appendix F, "Economic Analysis of the Dry Creek Project".

Project water requirements were based on two types of water use; urban or domestic, and agricultural. Urban water requirements were considered to be dependent upon the population served. Agricultural water requirements would depend upon the type and amount of crops to be irrigated.

Area of Investigation

Legislation authorizing the investigation of the Dry Creek Project stated that the study area should include all of Collayomi Valley and Long Valley. Consequently, the area of investigation was set up to encompass the entire area prescribed for study by the Legislature.

The area of investigation contains approximately 16,400 acres. In order to facilitate project planning, this area was divided into 11 subunits as shown on Plate 2, "Location of Subunits Within Area of Investigation". A description of these subunits is given in Table 3.

Land use and land classification surveys were made for the entire area of investigation. Land use data collected by reconnaissance field mapping during 1960 for Bulletin No. 99 was considered to represent present conditions of development, and was used to determine the type, location, and areal extent of irrigated, dry-farmed, and urban lands. A summary of present land use, by subunits, for the area of investigation is given in Table 4. Plate 3, "Land Use", shows present land use within the area of investigation.

The classification of agricultural lands within the area of investigation was accomplished during 1961 as part of a survey conducted under the Coordinated Statewide Planning Program. A summary of the land classification, by subunits, is given in Table 5. Plate 4, "Land Classification", shows the land classification within the area of investigation. The symbols used by the Department of Water Resources for identifying the different land classes and land uses are explained in Appendix D, "Extracts from Department of Water Resources Standard Land Classification and Land Use Legend".

#### Project Service Area

The project service areas described below are considered to be representative only. The exact limits of these areas cannot be determined until all the contracts for water service are executed.

TABLE 3  
DESCRIPTION OF SUBUNITS WITHIN  
AREA OF INVESTIGATION

| Subunit : | Description <sup>1/</sup>  |
|-----------|--|
| 1         | Outside MCWD <sup>2/</sup> and west of Dry Creek   |
| 2         | Outside MCWD, west of St. Helena Creek and east of Dry Creek                                     |
| 3         | Within MCWD and west of Dry Creek  |
| 4         | Within MCWD and east of Dry Creek in Long Valley   |
| 5         | Within MCWD, south of Middletown and bounded by Dry Creek, St. Helena Creek, and the city limits |
| 6         | Outside MCWD, within Middletown city limits and west of St. Helena Creek                         |
| 7         | Outside MCWD   |
| 8         | Outside MCWD and east of St. Helena Creek  |
| 9         | Within MCWD, north of Middletown and bounded by Dry Creek, St. Helena Creek, and the city limits |
| 10        | Outside MCWD, within Middletown city limits and east of St. Helena Creek                         |
| 11        | Within MCWD and east of St. Helena Creek in Collayomi Valley                                     |

<sup>1/</sup> The area of investigation was divided into subunits using MCWD, Dry Creek, and St. Helena Creek as boundaries.

<sup>2/</sup> Middletown County Water District.

TABLE 4

PRESENT (1960) LAND USE WITHIN AREA OF INVESTIGATION  
BY SUBUNITS  
(in acres)

| Land use        | Subunit |       |       |     |       |     |    |       |     |    |     | Total  |
|-----------------|---------|-------|-------|-----|-------|-----|----|-------|-----|----|-----|--------|
|                 | 1       | 2     | 3     | 4   | 5     | 6   | 7  | 8     | 9   | 10 | 11  |        |
| iP              | 70      | 1     | 159   | 87  | 76    | 0   | 0  | 0     | 120 | 0  | 0   | 513    |
| iD              | 153     | 0     | 25    | 0   | 35    | 0   | 0  | 0     | 0   | 0  | 13  | 226    |
| iT              | 0       | 0     | 2     | 0   | 6     | 0   | 0  | 12    | 0   | 0  | 9   | 29     |
| Total <u>3/</u> | 223     | 1     | 186   | 87  | 117   | 0   | 0  | 12    | 120 | 0  | 22  | 768    |
| nG              | 6       | 0     | 350   | 18  | 58    | 0   | 0  | 130   | 0   | 0  | 0   | 562    |
| nD              | 67      | 5     | 61    | 6   | 63    | 5   | 0  | 6     | 0   | 0  | 7   | 220    |
| nF              | 0       | 0     | 0     | 0   | 2     | 0   | 0  | 0     | 4   | 0  | 0   | 6      |
| nS              | 0       | 0     | 0     | 0   | 0     | 0   | 0  | 3     | 0   | 0  | 0   | 3      |
| nP              | 0       | 0     | 39    | 0   | 0     | 0   | 0  | 0     | 0   | 0  | 0   | 39     |
| Total <u>4/</u> | 73      | 5     | 450   | 24  | 123   | 5   | 0  | 139   | 4   | 0  | 7   | 830    |
| RT              | 0       | 1     | 0     | 0   | 0     | 0   | 0  | 0     | 0   | 0  | 0   | 1      |
| RC              | 0       | 6     | 0     | 0   | 6     | 0   | 0  | 0     | 0   | 0  | 0   | 12     |
| U               | 4       | 10    | 15    | 0   | 13    | 126 | 0  | 0     | 18  | 0  | 0   | 186    |
| Total <u>5/</u> | 4       | 17    | 15    | 0   | 19    | 126 | 0  | 0     | 18  | 0  | 0   | 199    |
| NV              | 1,612   | 1,220 | 1,584 | 765 | 1,617 | 53  | 31 | 6,902 | 57  | 22 | 746 | 14,609 |
| GRAND TOTAL     | 1,912   | 1,243 | 2,235 | 876 | 1,876 | 184 | 31 | 7,053 | 199 | 22 | 775 | 16,406 |

1/ Land use symbols are defined in Appendix D.

2/ Subunits are described in Table 3.

3/ Total irrigated.

4/ Total dry-farmed.

5/ Total urban and recreation.

TABLE 5

CLASSIFICATION OF LANDS WITHIN AREA OF INVESTIGATION  
BY SUBUNITS  
(in acres)

| Land class <u>1/</u> : | Subunit <u>2/</u> : |       |       |     |       |     |    |       |     |    |     |        | Total |
|------------------------|---------------------|-------|-------|-----|-------|-----|----|-------|-----|----|-----|--------|-------|
|                        | 1                   | 2     | 3     | 4   | 5     | 6   | 7  | 8     | 9   | 10 | 11  |        |       |
| Vh                     | 0                   | 0     | 0     | 288 | 0     | 0   | 0  | 109   | 0   | 0  | 0   | 397    |       |
| V                      | 233                 | 95    | 894   | 176 | 503   | 13  | 0  | 54    | 151 | 7  | 45  | 2,171  |       |
| Vp                     | 0                   | 0     | 65    | 53  | 112   | 25  | 0  | 1,226 | 0   | 4  | 62  | 1,547  |       |
| H                      | 144                 | 204   | 439   | 48  | 337   | 0   | 18 | 263   | 0   | 0  | 136 | 1,589  |       |
| Hp                     | 42                  | 0     | 0     | 156 | 0     | 0   | 0  | 1,259 | 0   | 0  | 73  | 1,530  |       |
| M                      | 13                  | 13    | 0     | 17  | 77    | 0   | 0  | 450   | 0   | 0  | 13  | 583    |       |
| Mp                     | 12                  | 5     | 5     | 0   | 23    | 0   | 0  | 358   | 0   | 0  | 0   | 403    |       |
| Total <u>3/</u>        | 444                 | 317   | 1,403 | 738 | 1,052 | 38  | 18 | 3,719 | 151 | 11 | 329 | 8,220  |       |
| RC                     | 0                   | 0     | 0     | 0   | 25    | 0   | 0  | 3     | 0   | 0  | 0   | 28     |       |
| RT                     | 0                   | 7     | 0     | 0   | 0     | 0   | 0  | 0     | 0   | 0  | 0   | 7      |       |
| UD                     | 4                   | 10    | 14    | 0   | 13    | 123 | 0  | 3     | 18  | 0  | 0   | 185    |       |
| N                      | 1,464               | 909   | 818   | 138 | 786   | 23  | 13 | 3,328 | 30  | 11 | 446 | 7,966  |       |
| Total <u>4/</u>        | 1,468               | 926   | 832   | 138 | 824   | 146 | 13 | 3,334 | 48  | 11 | 446 | 8,186  |       |
| GRAND TOTAL            | 1,912               | 1,243 | 2,235 | 876 | 1,876 | 184 | 31 | 7,053 | 199 | 22 | 775 | 16,406 |       |

1/ Land classification symbols explained in Appendix D.

2/ Subunits are described in Table 3.

3/ Total irrigable.

4/ Total nonirrigable.

### Service Area

The service area contains approximately 5,700 acres and is shown on Plates 3 and 4. A summary of the present land use within this area is given in Table 6.

The criteria used in selecting the project service area boundary were as follows:

1. Elevation of land - Lands which could not be served by gravity flow from the reservoir were excluded except for those lands where crops with a payment capacity higher than that required to more than cover the cost of developing and conveying the water could be produced.
2. Soil Conditions - Lands having adverse soil conditions which would prohibit their use in growing the higher payment capacity crop were excluded. These excluded lands have tight clay soils which originated in the high-magnesium serpentine rock materials of the hills along the northern border of Long Valley. Results obtained from fertilization trials on irrigated pasture, soil borings, and observations by agricultural specialists indicate that soils of this type will support pasture with a limited carrying capacity even under the best management conditions. Although it is possible that an intensive land reclamation program including such practices as the use of chemical amendments, deep ripping, and tilling could eliminate the limiting soil conditions, for the purposes of this study such a program was considered uneconomical.

### Gross Project Service Area

Approximately 460 acres of land within the service area presently receive a full water supply either from ground water or direct stream diversion and hence will not require project water. These lands were deducted from the service area to arrive at the gross project service area which totals 5,220 acres. The present land use within the gross project service area is shown in Table 6 and the land classification is given in Table 7.

TABLE 6

PRESENT (1960) LAND USE WITHIN  
PROJECT SERVICE AREA  
(in acres)

| Land use                 | :<br>: Service area | : Excluded<br>: lands <u>1/</u> | : Gross project<br>: service area |
|--------------------------|---------------------|---------------------------------|-----------------------------------|
| <u>Irrigated Lands</u>   |                     |                                 |                                   |
| Mixed Pasture            | 330                 | 330                             |                                   |
| Sudan                    | 80                  | 80                              |                                   |
| Walnuts                  | <u>50</u>           | <u>50</u>                       | <u>      </u>                     |
| Total-Irrigated Lands    | 460                 | 460                             | 0                                 |
| <u>Dry-Farmed Lands</u>  |                     |                                 |                                   |
| Grain and Hay            | 590                 |                                 | 590                               |
| Prunes                   | 30                  |                                 | 30                                |
| Apples                   | 10                  |                                 | 10                                |
| Walnuts                  | 90                  |                                 | 90                                |
| Miscellaneous Orchard    | 10                  |                                 | 10                                |
| Vineyard                 | <u>40</u>           | <u>      </u>                   | <u>40</u>                         |
| Total - Dry-Farmed Lands | 770                 | 0                               | 770                               |
| <u>Other Lands</u>       |                     |                                 |                                   |
| Present Urban            | 170                 |                                 | 170                               |
| Native Vegetation        | <u>4,280</u>        | <u>      </u>                   | <u>4,280</u>                      |
| Total - Other Lands      | <u>4,450</u>        | <u>0</u>                        | <u>4,450</u>                      |
| GRAND TOTAL              | 5,680               | 460                             | 5,220                             |

1/ Lands presently receiving a full irrigation supply from ground water or direct diversion were not provided project water.

TABLE 7

LAND CLASSIFICATION WITHIN  
GROSS PROJECT SERVICE AREA  
(in acres)

| <u>Land Class</u> <sup>1/</sup> | <u>Area</u> |
|---------------------------------|-------------|
| V                               | 1,470       |
| VP                              | 1,550       |
| H                               | 650         |
| Hp                              | 740         |
| M                               | 90          |
| Mp                              | <u>140</u>  |
| Total                           | 4,640       |
| Present Urban Lands             | 170         |
| Nonirrigable Lands              | <u>410</u>  |
| Total                           | <u>580</u>  |
| GRAND TOTAL                     | 5,220       |

<sup>1/</sup> Land classification symbols are defined  
in Appendix D.

### Net Project Service Area

The net project service area contains approximately 3,500 acres and represents the amount of land that is projected to be under irrigation with project water at full development. This area was established by reducing the gross project service area by those lands which would be utilized for roads, canals, farmsteads, and urban lands. Table 3 of Appendix F shows the projected crop pattern in the gross and net project service areas at full development.

### Project Water Requirements

#### Agricultural Water Requirements

The method used to estimate the present and future agricultural water requirements and attendant demands on the project was:

1. A future cropping pattern, considered indicative of the types of crops adaptable to the lands in the service area, was projected for the project service area.
2. Unit farm delivery irrigation requirements for each of the projected crops were derived.
3. The acreage projected for each crop was multiplied by the respective unit farm delivery irrigation requirement. Office studies indicated that the opportunity for reuse of applied water would compensate for conveyance losses from the reservoir. Irrigation demands on the reservoir were, therefore, assumed to equal farm delivery demands.

A summary of the estimated agricultural water demands for the 50-year period of analysis is given in Table 8 and shown graphically on Figure 3. Unit water requirements and irrigation efficiencies for the crops projected for the service area are given in Appendix F.

TABLE 8

ESTIMATED PROJECT WATER DEMAND  
(in acre-feet)

| Year of:<br>project:<br>life : | Agricultural<br>water<br>demand : | Urban<br>water<br>demand : | Total | :: Year of :<br>project :<br>life : | Agricultural<br>water<br>demand : | Urban<br>water<br>demand : | Total |
|--------------------------------|-----------------------------------|----------------------------|-------|-------------------------------------|-----------------------------------|----------------------------|-------|
| 1                              | 1,800                             | 150                        | 1,950 | 26                                  | 5,890                             | 310                        | 6,200 |
| 2                              | 2,350                             | 150                        | 2,500 | 27                                  | 5,890                             | 330                        | 6,220 |
| 3                              | 2,850                             | 160                        | 3,010 | 28                                  | 5,880                             | 350                        | 6,230 |
| 4                              | 3,200                             | 170                        | 3,370 | 29                                  | 5,870                             | 370                        | 6,240 |
| 5                              | 3,530                             | 180                        | 3,710 | 30                                  | 5,870                             | 390                        | 6,260 |
| 6                              | 3,850                             | 180                        | 4,030 | 31                                  | 5,850                             | 410                        | 6,260 |
| 7                              | 4,100                             | 180                        | 4,280 | 32                                  | 5,840                             | 420                        | 6,260 |
| 8                              | 4,400                             | 190                        | 4,590 | 33                                  | 5,820                             | 440                        | 6,260 |
| 9                              | 4,650                             | 190                        | 4,840 | 34                                  | 5,800                             | 460                        | 6,260 |
| 10                             | 4,900                             | 190                        | 5,090 | 35                                  | 5,780                             | 480                        | 6,260 |
| 11                             | 5,200                             | 200                        | 5,400 | 36                                  | 5,750                             | 520                        | 6,270 |
| 12                             | 5,400                             | 200                        | 5,600 | 37                                  | 5,720                             | 560                        | 6,280 |
| 13                             | 5,600                             | 210                        | 5,810 | 38                                  | 5,680                             | 600                        | 6,280 |
| 14                             | 5,860                             | 210                        | 6,070 | 39                                  | 5,650                             | 640                        | 6,290 |
| 15                             | 5,890                             | 220                        | 6,110 | 40                                  | 5,610                             | 680                        | 6,290 |
| 16                             | 5,890                             | 220                        | 6,110 | 41                                  | 5,570                             | 730                        | 6,300 |
| 17                             | 5,890                             | 220                        | 6,110 | 42                                  | 5,540                             | 780                        | 6,320 |
| 18                             | 5,890                             | 230                        | 6,120 | 43                                  | 5,520                             | 830                        | 6,350 |
| 19                             | 5,890                             | 240                        | 6,130 | 44                                  | 5,490                             | 880                        | 6,370 |
| 20                             | 5,890                             | 250                        | 6,140 | 45                                  | 5,470                             | 930                        | 6,400 |
| 21                             | 5,890                             | 260                        | 6,150 | 46                                  | 5,460                             | 980                        | 6,440 |
| 22                             | 5,890                             | 270                        | 6,160 | 47                                  | 5,430                             | 1,030                      | 6,460 |
| 23                             | 5,890                             | 280                        | 6,170 | 48                                  | 5,420                             | 1,090                      | 6,510 |
| 24                             | 5,890                             | 290                        | 6,180 | 49                                  | 5,410                             | 1,150                      | 6,560 |
| 25                             | 5,890                             | 300                        | 6,190 | 50                                  | 5,400                             | 1,200                      | 6,600 |

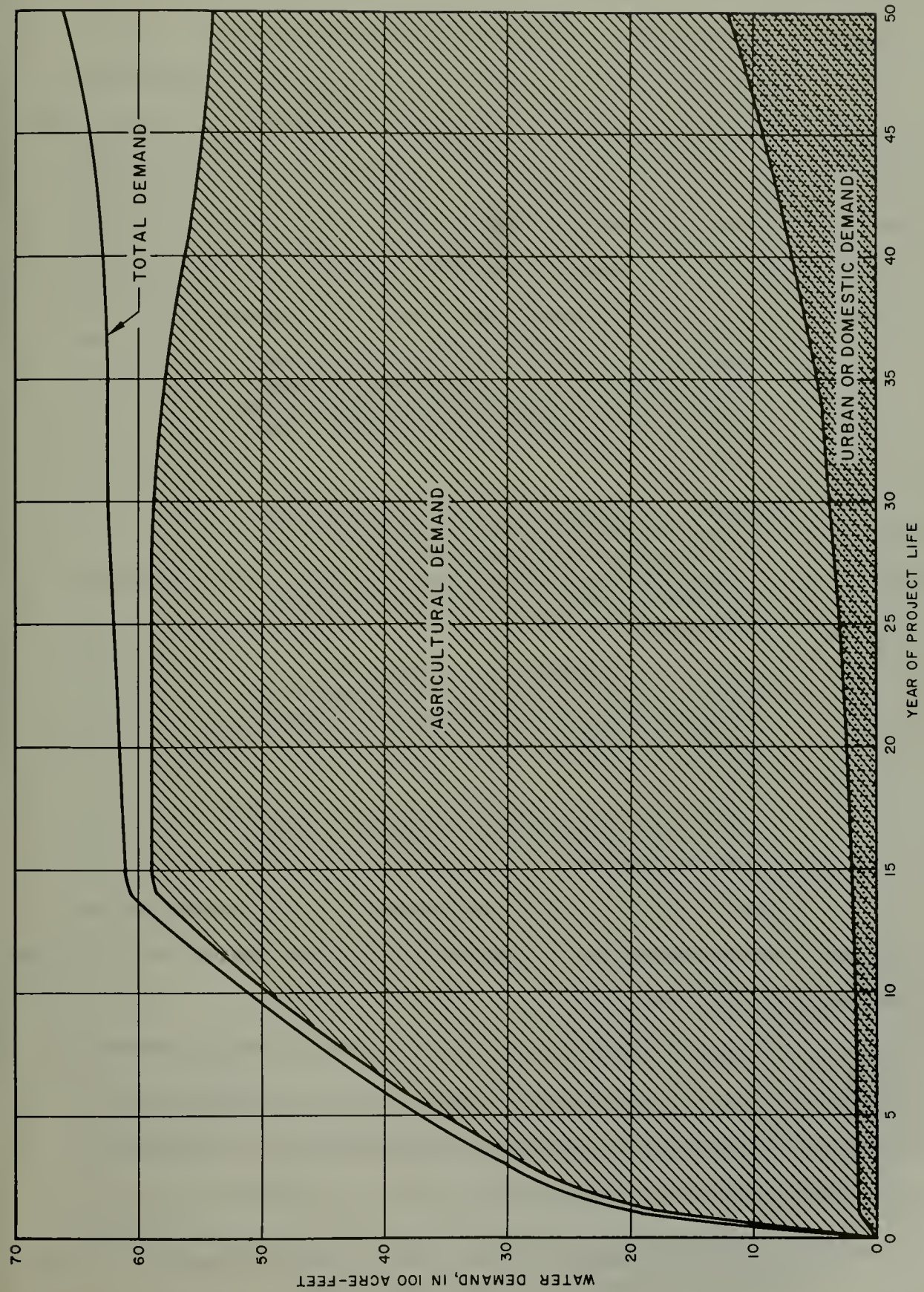


Figure 3. ESTIMATED PROJECT WATER DEMAND

Urban Water Requirements

The present and future urban water demands on the project will consist of domestic use by the municipal and residential farm <sup>1/</sup>population. Although not all residential farms will be supplied from the Middletown waterworks system, the domestic water use on residential farms was considered as part of the overall urban water requirement. The reasons for treating residential farm domestic water use in this manner were:

1. That portion of the residential farm population which does not obtain its domestic water from the Middletown waterworks system initially, may desire this service in future years.
2. Water for domestic use by the residential farm population should be available on a firm basis, regardless of whether it is obtained from the Middletown waterworks system or directly from the agricultural distribution system.
3. Benefits attributable to domestic water use on residential farms will exceed benefits attributable to agricultural water and will approximate the value shown for municipal water.
4. The demand schedule and benefits for domestic use on residential farms and in Middletown are similar.

Urban or domestic water requirements were determined from the product of the Middletown and residential farm population and the associated per capita rate of use.

A summary of the estimated urban water requirements for the 50-year period of analysis is given in Table 8 and shown graphically on Figure 3. The per capita urban water requirements and the population projections are given in Appendix F.

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<sup>1/</sup> A relatively large homesite, located in a rural environment, of which a portion is devoted to irrigated agriculture.

Water Shortages and Their Effect on Crop Yield

Droughty climatic periods will likely occur during the 50-year project repayment period. In these years of low rainfall, two conditions will affect crop yields. First, the annual winter runoff will not be sufficient to fill Collayomi Reservoir, thus resulting in a less than normal project water supply; and second, the portion of the crop water requirement normally met by carryover soil moisture and spring rainfall will be reduced. The irrigation water requirements used in computing the agricultural water demands were based on normal soil moisture and rainfall conditions.

To a degree, water shortages can be compensated for by increased irrigation efficiency. In the case of an unusually severe water shortage, where deficiencies might exceed 50 percent and thus cause prolonged physiological damage and economic loss to perennial crops, a priority system for allocating irrigation water could be established. Many irrigation districts have established a system of this type wherein perennial crops are given priority of water use over annual crops during dry years. To compensate for this preferential treatment, water charges for perennial crops are usually higher than for annual crops.

No published data concerning the relationship between water shortages and crop yields that can be applied directly to conditions in the Collayomi and Long Valley area are available. However, discussions with irrigation specialists and agricultural experts from the University of California at Davis, indicated the following reductions in marketable yield could reasonably be expected if a 50 percent seasonal irrigation deficiency should occur following a period of adequate water supply.

| <u>Crop</u>            | <u>Percent reduction in yield</u> |
|------------------------|-----------------------------------|
| Walnuts                | 10                                |
| Pears and Other Fruits | 20                                |
| Vineyard               | 25                                |
| Alfalfa and Pasture    | 50                                |
| Miscellaneous Field    | 25-50 <u>1/</u>                   |

1/ Dependent on season of growth. Early spring crops would be less affected than summer crops.

The size of the reservoir was determined by the relationship between the economic loss caused by a water shortage and the increase in cost of the project required to prevent this loss. This procedure is explained in detail in Chapter VI, "Plan of Development".

## CHAPTER V

General

Two sections of the California Water Code particularly relevant to recreation, and fish and wildlife development in project planning are:

"Section 12581. In studying water development projects, full consideration shall be given to all beneficial uses of the State's water resources, including irrigation, generation of electrical energy, municipal and industrial consumption of water and power, repulsion of salt water, preservation and development of fish and wildlife resources, and recreational facilities, but not excluding other beneficial uses of water, in order that recommendations may be made as to the feasibility of such projects and for the method of financing feasible projects.

"Section 12625. In determining the cost of any project, damage to fish and wildlife that will probably result must be included in the amount of the cost."

Studies by the Department of Parks and Recreation and the Department of Fish and Game were conducted as part of the overall project formulation study which led to the selection of the proposed plan of development.

The findings and conclusions of these studies and their effect are discussed briefly in this chapter and are described in more detail in Appendix I, "Report on the Recreation Potential of Collayomi Reservoir by the Department of Parks and Recreation", and Appendix J, "Comments and Recommendations on the Dry Creek Project by the Department of Fish and Game".

Recreation

The Dry Creek Project will provide a limited opportunity for recreation development. The major attraction and probably the major recreation use will occur as a result of the fishery potential of the reservoir.

The Department of Parks and Recreation and the Department of Fish and Game studied the potential recreation use projected for the project based on the following three alternative schemes of fishery management:

1. Warmwater fishery only.
2. Warmwater fishery plus an early season trout fishery.
3. Warmwater fishery plus a prolonged summer trout fishery made possible by controlling the temperature of the water within the reservoir.

The proposed onshore recreation features would be the same regardless of the fishery management scheme selected. Scheme number one would provide for warmwater fishing only. Scheme number two has the added advantage in that it would provide trout fishing during the early summer months. In order to provide satisfactory angling under this scheme, it would be necessary to stock the reservoir annually with catchable sized trout. To prolong the summer trout fishery, as proposed in scheme number three, the installation of a variable stage outlet tower or similar device for controlling the water temperature in the reservoir would be required.

The capital cost of developing onshore recreation facilities is estimated to be about \$550,000 <sup>1/</sup>. The average annual equivalent cost would be approximately \$21,380 <sup>1/</sup>. The Department of Fish and Game has estimated under scheme number two that an additional expenditure of \$10,000 annually would be needed to stock the reservoir with catchable sized trout. Costs, in addition to those associated with onshore recreation facilities, would be required to construct, operate, and maintain the more elaborate outlet works necessary under scheme number three.

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<sup>1/</sup> These costs reflect the standards of construction employed by the Department of Parks and Recreation. A breakdown of costs is given in Appendix I.

The estimated annual recreation use by decades for each of the three schemes and a proposed land use and acquisition plan of the recreation areas are included in Appendix I.

In order to determine the magnitude of benefits attributable to recreation, scheme number 2 was analyzed. Appendix F shows the average annual recreation benefit under this scheme would be \$26,960. A value of \$0.50 per visitor-day was used to conform with Department policy in place of a lesser value computed by the modified Trice-Wood Method. Recreation benefits attributable to the other two schemes were not analyzed in this detail; however, they can be readily evaluated by comparison with scheme number two.

#### Reservoir Size and Recreation Development

The topography in the area of the reservoir is generally steep. Thus, suitable lands available for recreation use adjacent to the reservoir limit both the number and extent of recreation sites. Figure 4 shows the gross reservoir storage capacity in acre-feet, plotted against the developable recreation land in acres. It can be seen that as the reservoir size increases, lands available for recreation use decrease.

The benefits per acre-foot of storage for both agricultural and domestic use exceed the benefit per acre-foot of storage for recreation use. Therefore, to maximize net project benefits, the initial increment of reservoir storage developed was allocated to agricultural and domestic uses. The amount of active reservoir capacity required to optimize these uses was estimated to be 6,000 acre-feet. By providing 600 acre-feet for dead storage, the gross capacity of the reservoir was established at 6,600 acre-feet. Since construction of a reservoir larger than 6,600 acre-feet

would decrease the developable acreage and, hence, the benefits attributable to recreation, the optimum reservoir capacity to provide for all project purposes (agriculture, domestic, recreation) would be 6,600 acre-feet.

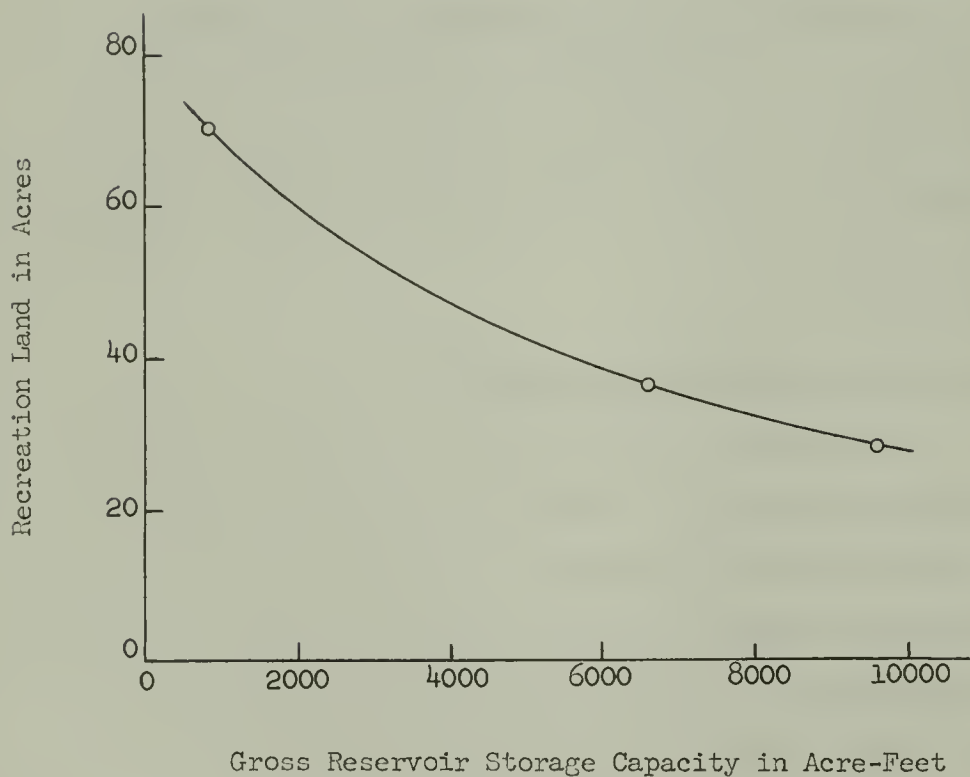


Figure 4. Developable Recreation Land Adjacent to Collayomi Reservoir.

Fish and WildlifeFishery

At the present time there is an estimated average trout density of 211 harvestable fish per stream mile in Dry Creek above and below the damsite. The reach of stream extending from the upper edge of the reservoir to the confluence of Dry Creek with Putah Creek was estimated to have the ability to support 312 angler-days of fishing annually.

No attempt was made in the project studies to provide reservoir releases which would maintain the trout fishery below the damsite under project conditions. Releases from the reservoir required to support a fishery in this reach would be sizable and would necessitate increasing the reservoir storage by an amount equal to the sum of the releases made during the critical dry period. The cost of this increased storage, and the resulting loss in recreation benefits caused by inundating developable recreation areas adjacent to the reservoir, dictates that the best scheme of development would include a fishery in the reservoir rather than downstream.

The existing fishery potential of the area would be advanced under any of the three schemes of development suggested by the Department of Fish and Game. Inclusion of a 600 acre-foot dead storage pool will provide a warmwater fishery in the reservoir which will more than compensate for the loss of fishing in the reach of stream below the damsite. Annual fish planting costs and estimated annual angler-use figures are given in Appendix J.

Wildlife

Construction of the project will have an adverse effect on the wildlife in the area. The detriment to wildlife other than deer was considered to be minor and the monetary value was not estimated.

Recent land ownership changes have eliminated public deer hunting opportunities in the area. Prior to these changes, an estimated 195 hunter-days of annual use occurred in the Dry Creek Drainage Basin. At present, the proposed reservoir area supports a population of about 19 deer.

The project plan of development includes a water distribution system which would ring much of Collayomi Valley and Long Valley at an elevation of approximately 1,200 feet. Nearly 15 miles of this system would consist of an open, concrete-lined canal. This canal will bisect the deer range by separating the shelter of the wooded slopes from the open grazing lands which lie below the proposed alignment.

While the canal is not expected to present a threat to adult deer, the Department of Fish and Game is concerned about the possible loss of fawns from drowning. Without further study, it is not possible to indicate the sections of the canal which might be dangerous. However, a study of this problem is being conducted by the Department of Fish and Game and the results should be available in the near future. For the present, it was assumed that only the initial canal section carrying the maximum releases would require fencing. This section would extend from the outlet of the dam to the first concrete pipe lateral, a distance of 3,500 feet.

To compensate for the loss of the grazing range in the reservoir area, the Department of Fish and Game proposes that access be provided to other public lands in the area. Two parcels of public domain lands, totaling about 4,400 acres, are located in the Mayacmas Mountain Range west of the project. This land is presently isolated from use by the public because of lack of access.

The U. S. Bureau of Land Management has indicated a willingness to construct and maintain access roads to these areas if adequate rights-of-way can be secured. The cost of a 60-foot right-of-way for the 2.7 miles of road needed to gain access to the public lands and the cost of fencing the initial canal section was included as part of the project costs as required by Section 12625 of the California Water Code.

#### Project Recreation Costs and Benefits

The plan of development as proposed in this report does not include benefits or costs attributable to recreation use and development. The reasons for excluding these factors are:

1. The type of fishery management scheme to be included as part of the plan of development should be decided by the local agency responsible for the construction and operation of the project.
2. The scheme selected will determine the benefits and costs involved.
3. The scheme selected will have no effect on the physical features of the Dry Creek Project as outlined on Plate 5, "Plan of Development".
4. The scheme selected must have a benefit-to-cost ratio of at least 1:1 to be considered economically justified. Therefore, the overall plan of development will remain economically justified regardless of the scheme of recreation development selected.

#### Watershed Protection and Flood Prevention Act

Recent legislation has permitted greater participation by the Federal Government in developing recreation for projects financed under Public Law 83-566, as amended. Section 103 of Public Law 87-703, approved

September 27, 1962, provides for federal cost sharing for public recreation or fish and wildlife development in Public Law 83-566 projects. The U. S. Soil Conservation Service is responsible for the administration of PL 83-566 and establishment of policy concerning project eligibility, cost sharing, and evaluation of benefits. Selection of a fishery management scheme and plans for a recreation development should be coordinated with this agency if financing under PL 83-566 is pursued.

#### Davis-Grunsky Act

There is a possibility of obtaining a grant under the Davis-Grunsky Act for fishery and wildlife enhancement associated with the overall plan of development. This possibility should be investigated further if fishery management and associated reservoir recreation facilities are included as a part of the project.

## CHAPTER VI

General

In previous sections of this report, information was presented covering (1) the need for a supplemental water supply, (2) the availability of water for development, and (3) the amount of supplemental water required to meet the projected requirements. The project, as described in this chapter, will provide the necessary supplemental water supply for the service area. The major components of the project consist of a dam and reservoir to store surplus winter flows, and a distribution system to convey the water to the service area.

The dam will be an earthfill structure located on Dry Creek in the SW 1/4 of Section 4 and the NW 1/4 of Section 9, T10N, R7W, MDB&M, at an approximate streambed elevation of 1,168 feet, USC&GS Datum. Gross storage capacity in the reservoir will be 6,600 acre-feet at normal water surface elevation of 1,282 feet. An inactive pool of 600 acre-feet will be provided for debris and silt storage and preservation of fishlife.

The distribution system will consist of lined canals and pipelines for delivery of agricultural water to the farm headgates and domestic water to the Middletown water system. Conduit capacities range from a maximum of 45 second-feet at the dam outlet to a minimum of 1.0 second-foot.

The location of the project and a plan view of the principal features are delineated on Plate 5, "Plan of Development".

It should be noted that while the studies leading to the proposed plan of development are considered adequate to establish engineering and financial feasibility, the location of particular features and their final

designs and costs may differ somewhat from the values determined in this study. This is particularly true of the distribution system where the desired result can be achieved by various combinations of sizes and alignments of canals and pipelines. The layout of the distribution system, dam and reservoir, and the designs shown for these features are presented only for the purpose of illustrating the engineering practicality of the project and to obtain representative costs.

#### Sizing of Project Features

Reservoir sizing, and consequently reservoir capacity, is inter-related with the type and efficiency of the distribution system. As an example, an unlined system having large conveyance losses would require a greater reservoir yield than would a lined system. Furthermore, the head needed to effectively operate a gravity distribution system is a factor in establishing the elevation of the minimum pool of the reservoir.

#### Distribution System

The layout of the distribution system was made using USGS quadrangle maps and the latest available information on property and ownership lines. Because of the length of the system and the relatively small flows involved, a lined system was selected to minimize conveyance losses. It is possible that short reaches within the canal system could be unlined. This can be determined by tests of the soil characteristics prior to construction.

The criteria used in determining the canal and pipeline capacities were:

1. Capacity of the system must be capable of carrying peak agricultural water requirements.
2. Domestic water will be delivered to the municipal water agency in Middletown during periods of offpeak use of the conveyance system for irrigation purposes. This agency will have to provide sufficient holdover storage so that water can be delivered to the users on a domestic demand schedule.
3. The pipeline to Middletown will convey water for both domestic use and agricultural use. This pipeline was sized large enough to carry the 50-year domestic water requirement since this demand will exceed the peak agricultural demand in the reach.
4. All lands, with the exception of those in the southern portion of Long Valley and Collayomi Valley, will be served by gravity flow.

Data presented in Table 9 were used to estimate the design capacities of the various reaches and laterals. The table, which relates irrigated area in acres and required conduit design capacity in second-feet, was derived to satisfy the characteristics peculiar to the service area. Some of the factors taken into consideration in deriving this table were the service area cropping pattern, assumed irrigation practices, and estimated water costs.

TABLE 9

## ESTIMATED CANAL AND PIPELINE DESIGN CAPACITIES

| <u>Irrigated area<br/>in acres</u> | <u>Required conduit design capacity<br/>in second-feet</u> |
|------------------------------------|--|
| 0-20                               | 0.5  |
| 20-40                              | 0.7  |
| 40-60                              | 1.0  |
| 60-90                              | 1.4  |
| 90-120                             | 1.8  |
| 120-160                            | 2.1  |
| 160-200                            | 2.5  |
| 200-240                            | 2.8  |
| 240-1000                           | A/80 $\frac{1}{2}$   |
| 1000-up                            | A/100 $\frac{1}{2}$  |

$\frac{1}{2}$  "A" = area served in acres.

Using the criteria shown in Table 9 and information given in Appendix F, the maximum release required from the reservoir was computed to be about 45 second-feet. Conveyance losses in the system were assumed to equal usable return flows. Irrigation demands at the farm headgates were, therefore, equal to reservoir releases.

### Reservoir

A method commonly used to determine optimum reservoir capacity is based upon the allowable water deficiencies in a dry year. Under this method, the reservoir is operated for the selected historical period and the reservoir size is assumed to be optimized when water shortages equal the limiting values chosen.

The main drawback in applying this method is the difficulty of selecting the proper allowable water deficiency. Permissible deficiencies are dependent on many factors, such as the type of crops grown and the frequency and magnitude of deficiencies. Attempts to apply a broad criterion

to a particular service area often fail to take into account the physical and economic characteristics peculiar to that area.

A more logical method of establishing permissible deficiencies is to determine the effects of water shortages of various magnitudes on net project income and from this, the justifiable expenditure required to prevent or decrease these shortages. This method was used in sizing Collayomi Reservoir.

For nonindustrial cities such as Middletown, water shortages at infrequent intervals (every 15 to 20 years) can usually be tolerated. The rationing of water for car washing, lawn watering, and other non-essential uses will not cause an appreciable economic loss, although the inconvenience is undesirable. Since the additional project costs required to ensure a firm water supply are easily within the payment capacity of the urban water users, it was assumed that no urban water deficiencies would be allowed.

The maximum allowable water shortage for irrigated crops is, as previously stated, primarily dependent upon the economic effect of the shortage. The economic analysis to establish the allowable water shortage for irrigated crops was based on the assumption that: (1) the decrease in net returns to agriculture resulting from a water shortage is an economic loss attributable to that shortage, and (2) the reservoir size will be optimized when the increment of cost to reduce water shortages by increasing reservoir storage equals the increment of economic loss caused by the water shortages.

A study to determine the optimum size of Collayomi Reservoir was accomplished as follows.

A cost curve showing the variation in capitalized cost with storage in Collayomi Reservoir was derived. This is shown as Curve A of Figure 5. The capitalized cost includes the present worth of the annual operation and maintenance costs during the 50-year repayment period.

Operation studies were run for gross reservoir storage capacities of 6,100, 6,600, and 7,200 acre-feet during the estimated project water requirements for the 50-year repayment period. Inactive capacity was 600 acre-feet in each case. The available water yield was evaluated using the 50-year sequence of historical flows in Dry Creek from 1906 through 1955. Selection of the 50-year flow sequence was based on the assumption that the sequence chosen should be such that the present worth of economic losses to the project, caused by a shortage of water during dry years, would be a maximum. Under this approach, it is possible to determine the effect on a project should the severe historical conditions recur. The water shortages occurring for each of the three reservoir sizes are summarized in Table 10.

The economic loss, or reduction in net farm income resulting from a water shortage, was then computed in the following manner.

A curve relating economic loss in dollars per acre-foot of agricultural water shortage to water shortage in percent of normal supply for agriculture was developed. Economic losses were derived assuming that perennial crops would have a higher priority for water during drought periods than would annual crops. Using data relating water shortage and economic loss as shown in Table 10, the aggregate economic loss during the 50-year repayment period was computed for gross reservoir capacities of 6,100, 6,600, and 7,200 acre-feet. To allow a direct comparison with project costs, the aggregate economic loss was converted to present worth assuming a 3 percent interest rate. These data are summarized in Table 11. A graphic presentation

TABLE 10

ESTIMATED WATER SHORTAGES DURING 50-YEAR  
REPAYMENT PERIOD AT VARYING RESERVOIR CAPACITIES  
(in acre-feet)

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|           |           |    |           |           |
|-----------|-----------|----|-----------|-----------|
| Project : | Water     | :: | Project : | Water     |
| year :    | shortages | :: | year :    | shortages |

---

At 6,100 Acre-Feet Gross Reservoir Storage

|    |       |    |       |
|----|-------|----|-------|
| 13 | 270   | 26 | 2,370 |
| 14 | 330   | 27 | 220   |
| 15 | 1,070 | 28 | 180   |
| 16 | 290   | 29 | 600   |
| 17 | 440   | 31 | 100   |
| 18 | 230   | 32 | 110   |
| 19 | 1,800 | 34 | 1,570 |
| 21 | 60    | 41 | 320   |
| 23 | 130   | 42 | 210   |
| 24 | 530   | 44 | 290   |
| 25 | 320   | 45 | 270   |

At 6,600 Acre-Feet Gross Reservoir Storage

|    |       |    |       |
|----|-------|----|-------|
| 15 | 950   | 26 | 2,230 |
| 19 | 1,590 | 29 | 130   |
| 24 | 60    | 34 | 980   |

At 7,200 Acre-Feet Gross Reservoir Storage

|    |       |    |       |
|----|-------|----|-------|
| 15 | 390   | 26 | 1,680 |
| 19 | 1,020 | 34 | 540   |

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Note: Shortages based on historic sequence of flows in Dry Creek for the period 1906 - 1955.



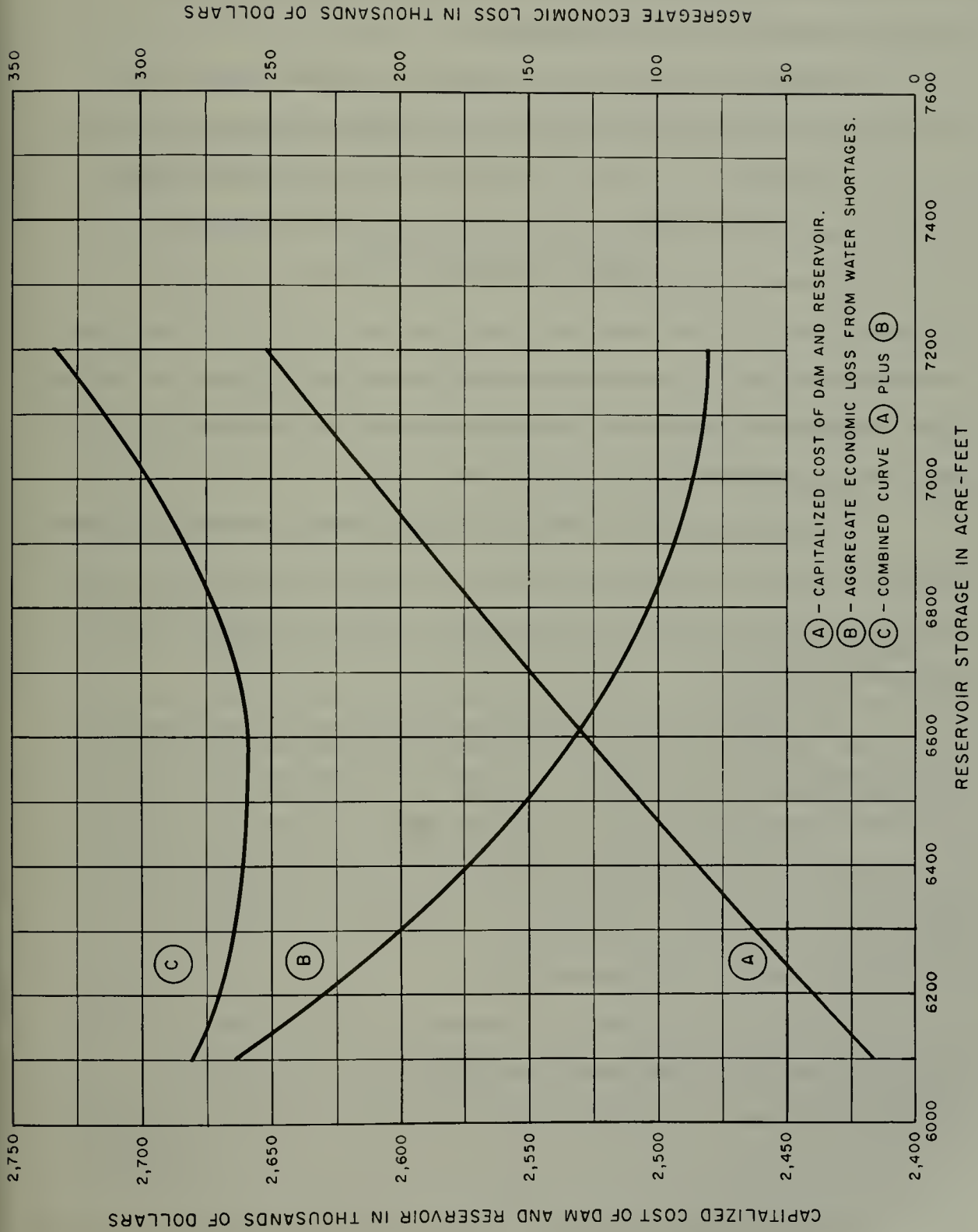


Figure 5. CAPITALIZED COST AND AGGREGATE ECONOMIC LOSS RELATIONSHIP FOR COLLAYOMI DAM AND RESERVOIR

of the variation of the aggregate economic loss with gross reservoir capacity is shown as Curve B in Figure 5.

If Curve A and Curve B of Figure 5 are plotted to the same scale and combined as shown by Curve C, the optimum reservoir size can readily be determined. Curve C shows that for gross reservoir sizes greater than 6,600 acre-feet, the cost of reducing the deficiencies exceeds the economic loss caused by the deficiency. This curve also indicates that for gross reservoir sizes less than 6,600 acre-feet, the cost of preventing or decreasing the deficiencies is less than the economic loss caused by the deficiency. The optimum gross storage capacity, therefore, was determined to be 6,600 acre-feet.

A monthly operation study of Collayomi Reservoir for the 50-year period of analysis, along with schedules of project water demand for reservoir evaporation, is given in Appendix G, "Monthly Operation Study of Collayomi Reservoir".

In addition to the above described analysis, a check was made on the capability of the reservoir to satisfy demands for water under the most severe combination of demand and deficient water supply. This situation would occur if demands as projected for the 50th year of project life were to occur under conditions of water supply experienced in the critical dry period, 1928 through 1934.

Assuming a firm supply is maintained for urban uses, a shortage of about 51 percent in the supply for agricultural use would occur in 1931. Shortages of about 5 percent in 1929 and in 1934 would also be experienced. As noted in Chapter IV, "Land and Water Use", crops of the type projected for the service area can tolerate a shortage in water supply of this magnitude.

The criteria established for deliveries of agricultural water from the State Water Project permits similar shortages during critically dry years. The permissible shortages are a maximum of 50 percent in any one year and a maximum of 100 percent of one year's supply in any series of 7 consecutive dry years.

### Design Criteria and Scope

#### Mapping

A map of the dam and reservoir area to a scale of 1:3600 with a contour interval of 10 feet was prepared from aerial photographs. This map was used for the layout of the dam and related features and for determining embankment and excavation quantities.

#### Geology

The geologic investigation conducted for Collayomi Dam and Reservoir consisted of surface mapping, drilling the dam foundation and borrow areas, laboratory soil testing, and seismic surveying. On the basis of results obtained from this program the damsite is considered suitable for the construction of a 129-foot high earthfill structure.

Three core holes were drilled along the axis of the dam and water tested. The tests showed the rock to be rather tight, and leakage is not expected to be a problem.

Some silting of the reservoir will occur, but due to the characteristics of the drainage area, the rate is expected to be low and of minor consequence.

An adequate supply of impervious material is available within 3,000 feet of the damsite. Stream gravels can be obtained along Putah Creek about 3 miles to the northeast. Riprap and rockfill materials can be quarried at Dog Rock about 1-1/2 miles to the west.

Appendix E, "Engineering Geology of Collayomi Dam and Reservoir", presents detailed geologic information on the damsite, borrow areas, and reservoir.

#### Distribution System

The distribution system will consist of approximately 15 miles of concrete lined canals and 12 miles of pipeline. The system will ring much of Collayomi Valley and Long Valley at about the 1,200-foot elevation.

A typical canal section is shown on Plate 5. The section was kept essentially constant throughout the system for ease of construction.

The canal will have a bottom width of 2 feet, 1-1/2 to 1 side slopes (1.5:1), and will be concrete lined to 6 inches above the maximum waterline. The depth of water will vary from approximately 0.75 feet to 2.0 feet depending on the canal reach and the capacity required.

Concrete pressure pipe was selected for use as a typical pipeline system and to obtain representative costs. Pipe sizes varied from 6 inches to 36 inches in diameter.

#### Dam and Related Features

An inactive pool of 600 acre-feet was provided in Collayomi Reservoir. This amount was deemed sufficient to allow for sedimentation during the economic life of the project. It will also provide the necessary head to allow irrigation of most of the lands within the project

service area by gravity flow, as well as maintain a pool for the preservation of resident fishlife during periods of extreme drawdown.

The dam will be 129 feet high with a crest length of 1,285 feet, and a crest width of 20 feet. Due to the availability of impervious material, an earthfill structure was chosen for this site. Stability analyses for various conditions, including a seismic force of 0.1g, were applied. Side slopes of 3:1 upstream and 2.5:1 downstream were found to be adequate. Horizontal and vertical drains should be provided in the fill material to control and alleviate seepage forces in the downstream portion of the dam. The total volume of fill will be about 1,225,000 cubic yards.

The probable maximum flood at the Dry Creek site was estimated to have a peak flow of 12,000 second-feet. Flood routing studies show that passage of the probable maximum flood through Collayomi Reservoir will reduce the peak flow through the spillway to about 10,000 second-feet.

The spillway will be excavated around the left abutment and will discharge into Dry Creek below the toe of the dam. Control will be provided by a concrete ogee weir having a length of 50 feet. Lining of the entire spillway chute is recommended. A stilling basin was provided at the end of the chute to reduce the velocity of the water and prevent scour and erosion of the creek bed. The maximum surcharge head on the weir will be 14 feet, leaving a freeboard above maximum water level of 1 foot.

The outlet works at the dam will consist of a 36-inch diameter reinforced concrete pipe placed in a trench on bedrock in the channel. Emergency shutoff of the pipe will be provided by a hydraulically operated slide gate contained in a submerged intake structure located just upstream from the dam. Releases from the reservoir for agricultural and urban use

will be controlled by a 30-inch hollow jet valve, discharging into a concrete stilling basin located along the right abutment just below the dam. From the stilling basin, releases will enter the distribution system for delivery to the service area. The general plan and typical sections of the dam, spillway, and outlet works are shown on Plate 6, "Collayomi Dam".

### Project Costs

The initial capital cost of the Dry Creek Project was estimated to be \$3,359,700. Of this amount, \$2,471,700 would be for the dam and reservoir and \$888,000 for the water distribution system. A detailed cost estimate of the dam and reservoir and the distribution system is given in Appendix H, "Estimated Capital Cost of the Dry Creek Project".

### Operating the Project

A coordinated plan of operation should be formulated if optimum use of the project is to be realized. A planned irrigation schedule will enable maximum efficiency to be obtained from the distribution system. Sale of urban water by contract to the municipal water district in Middletown will probably be on a firm yield basis. This will require that sufficient water be kept in the reservoir to assure an adequate urban supply during the dry years. Since severe agricultural water shortages will occur during exceptionally dry years, it may be advisable to have a plan for allocating water during such periods. Many irrigation districts give priority to the irrigation of perennial crops during droughty years. Otherwise, a possibility exists that these crops may suffer prolonged damage due to irreversible physiological effects.

## CHAPTER VII

Project Benefits

Benefits attributable to the Dry Creek Project will be derived from two sources; the sale of water for irrigation of agricultural lands, and the sale of water for urban use. Primary benefits will also accrue from recreation use in the reservoir area if the necessary facilities are provided.

Project benefits were evaluated based on long-term projections of agricultural and urban development. These projections and the estimated project benefits are shown in detail in Appendix F.

It should be noted that the benefits, as derived in this report, were not developed using standard Department of Water Resources criteria. Rather, they are based on the criteria used by the U. S. Soil Conservation Service for evaluating projects to be financed under Public Law 83-566, as amended. The project was analyzed using Public Law 83-566 criteria in compliance with a resolution <sup>1/</sup> by local interests stating their intent to seek financial assistance under the Watershed Protection and Flood Prevention Act.

The primary difference in the economic criteria of the two agencies is the method used to compute agricultural benefits. These benefits, under the criteria followed by the U. S. Soil Conservation Service, are considered to equal the increase in net farm income resulting from provision or improvement of a water supply, and includes the benefit derived from the enhanced opportunity for exercise of managerial skill. The standard criteria used

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<sup>1/</sup> Letter of Resolution, Dry Creek Project, Appendix A.

by the Department considers benefits attributable to agriculture to equal the increased return to land and water, and does not consider the increased return to management as a direct project benefit.

#### Agricultural Benefits

Agricultural benefits were derived by evaluating the difference in net income under dry-farmed and irrigated conditions. The net income was that amount remaining after growing, harvesting, and all other production costs, exclusive of water, land and management costs, were deducted from the gross value of production.

The historical agricultural crop prices and yields used in the economic analysis were based on the weighted average prices reported in the annual reports of the Agricultural Commissioners of Lake and Napa Counties for the base period 1952-56, inclusive. Prices were further adjusted by the use of the U. S. Department of Agriculture long-term projected "Prices Received and Prices Paid" indices to reflect the net income over the 50-year period of analysis.

The projected yields are based on historical averages with slight adjustments made according to the types of land projected for a particular crop. In some cases, the projected yields are higher than the historical yields because of these adjustments. Consequently, the net income from the project would be slightly greater than if it were derived on the basis of historical yields.

#### Urban Benefits

Benefits associated with the development of an urban water supply are normally based upon the concept of vendibility, limited by the least

costly alternative source. Since there was no practical or feasible alternative source of urban water, benefits were computed on the basis of vendibility.

#### Residential Farm Benefits

Project benefits attributable to residential farms were not computed as a separate category. Water used on residential farms will be for both agricultural and domestic water purposes. The water used to irrigate agricultural crops was assumed to provide an average benefit per acre-foot equal to the overall agricultural benefit per acre-foot derived for the project service area. The domestic portion of the water requirement was credited with having the same average benefit per acre-foot as the water provided for urban use in the Middletown area.

#### Recreation Benefits

Project benefits, as shown in this report, do not include benefits attributable to recreation use. The effect of recreation on the project was covered in Chapter V, "Recreation, Fish and Wildlife".

#### Intangible Benefits

Many intangible benefits attributable to a project are not susceptible to monetary measurement and are not included in the computation of project benefits. These benefits include such effects as improvement of water quality, reduction of fire insurance rates resulting from improved fire protection, and the improvement of aesthetic values from watering of lawns and park areas.

Middletown does not have a public water system and is supplied from private domestic wells which often serve several dwellings. Some of

the shallow wells in town go dry in the summer months, and, in such cases, water is generally obtained from a deeper neighboring well. A major disadvantage of the present system, in addition to its unreliability, is the potentially dangerous problem of water pollution. The town does not have a municipal sewerage system, relying instead on home septic tanks. There is some concern by health authorities over the possible contamination of the domestic water supply if these methods of sewage disposal and water supply are allowed to continue. With an adequate, dependable water supply, a modern municipal waterworks system could be constructed in Middletown. This would enable the community to maintain safe public health and fire protection standards.

A summary of the primary benefits attributable to the Dry Creek Project is given below.

| Type of benefit  | :<br>: Total for 50-<br>: year period | :<br>: Present<br>: worth <u>1/</u> | :<br>: Average annual<br>: equivalent |
|--|---------------------------------------|-------------------------------------|---------------------------------------|
| <u>Irrigation</u>  |                                       |                                     |                                       |
| Net income with project  | \$15,128,470                          | \$6,380,380                         | \$248,000                             |
| <u>Urban</u>   |                                       |                                     |                                       |
| Domestic water sales   | <u>844,000</u>                        | <u>342,500</u>                      | <u>13,320</u>                         |
| Subtotals  | \$15,972,470                          | \$6,722,880                         | \$261,320                             |
| Less net income<br>without project                                   |                                       |                                     | <u>22,440</u>                         |
| Net annual increase in income  |                                       |                                     | \$238,880                             |
| Less associated on-farm operation<br>and maintenance costs <u>2/</u> |                                       |                                     | <u>5,250</u>                          |
| Net annual benefits from project                                     |                                       |                                     | \$233,630                             |

1/ Adjusted to long-term prices paid to prices received index.

2/ Includes cost of on-farm land leveling, irrigation system, land drainage and fencing. Associated capital costs have already been included in initial crop budget analysis.

### Economic Justification

A project is considered to be economically justified when benefits accruing to the project exceed the costs incurred in its design, construction, operation, and maintenance. If the project is a multi-purpose project, each separate purpose must provide benefits at least equal to its cost. The comparison of the benefits and costs is commonly expressed as a benefit-to-cost ratio.

A comparison of the total primary project benefits, which have an average annual equivalent value of \$233,630, to the total project costs, which have an average annual equivalent value of \$143,000, indicates that the Dry Creek Project would have a benefit-to-cost ratio of 1.6 to 1. The project, therefore, can be considered economically justified.

Benefits evaluated for this project include only primary benefits. Primary benefits are those that can be measured in monetary terms, whereas intangible benefits, although real, cannot be measured. Since intangible benefits are not reflected in benefit-cost ratios, the ratio as shown above should be used as a guide and not considered the only criterion on which to measure the worth of the project.

### Cost Allocation

Project costs can be grouped into two categories: (1) the cost to be paid by the local water users, and (2) the cost to be paid by the Federal Government. This cost sharing feature is one of the provisions of the Watershed Protection and Flood Prevention Act (Public Law 83,566, as amended).

The share of the project costs allocated to the Federal Government is nonreimbursable. A loan carrying a 3 percent interest rate can be requested from the U. S. Farmers Home Administration to finance the portion of the costs to be paid by the local water users.

The proportionate use of facilities method, which is utilized by the U. S. Soil Conservation Service, was used to allocate project costs. A summary of the allocated capital and annual costs is given in Tables 12 and 13.

#### Financial Feasibility

Financial feasibility relates financial costs to project revenues. A project is financially feasible if: (1) the beneficiaries are ready, willing, and able to pay the reimbursable costs for project products and services within the repayment period; (2) sufficient capital is authorized and available to finance construction to completion; and (3) estimated revenue to be derived during the prescribed repayment period is sufficient to cover reimbursable project costs.

The portion of the total project cost to be repaid by the water users is dependent upon the type of financing that will be used. As previously stated, the project was analyzed on the assumption that it would be financed under the "Watershed Protection and Flood Prevention Act", Public Law 83-566, as amended. The allocation of project costs was made using criteria provided by the U. S. Soil Conservation Service, the agency responsible for the approval of projects seeking financing under Public Law 83-566.

TABLE 12

SUMMARY OF THE ALLOCATED CAPITAL COST  
FOR THE  
DRY CREEK PROJECT

| Feature                         | :           | Agriculture |             |           | :           | Domestic | : |       |
|---------------------------------|-------------|-------------|-------------|-----------|-------------|----------|---|-------|
|                                 | :           | Federal     | :           | Local     | :           | Local    | : | Grand |
|                                 | :           | cost        | :           | cost      | :           | cost     | : | total |
|                                 | :           | (49%)       | :           | (51%)     | :           | (100%)   | : |       |
| Dam and Reservoir <sup>1/</sup> | \$1,138,600 | \$1,185,000 | \$2,323,600 | \$148,100 | \$2,471,700 |          |   |       |
| Distribution System             |             |             |             |           |             |          |   |       |
| Agriculture                     | 408,700     | 425,400     | 834,100     | ---       | 834,100     |          |   |       |
| Domestic                        | ---         | ---         | ---         | 53,900    | 53,900      |          |   |       |
| TOTAL                           | \$1,547,300 | \$1,610,400 | \$3,157,700 | \$202,000 | \$3,359,700 |          |   |       |

<sup>1/</sup> 94 percent of total cost allocated to agriculture.

Federal cost (nonreimbursable) = \$1,547,300

Local cost (reimbursable) = \$1,812,400

Total Project Cost = \$3,359,700

TABLE 13

SUMMARY OF THE ALLOCATED ANNUAL COST  
FOR THE  
DRY CREEK PROJECT

| Item                                       | Agriculture |          |           | Domestic: |          |          |           |  |
|--|-------------|----------|-----------|-----------|----------|----------|-----------|--|
|  | Federal     | Local    | Total     | Local     | federal  | local    | total     |  |
|  | cost        | cost     |           | cost      | cost     | cost     |           |  |
|  |             |          |           |           |          |          |           |  |
|  | (1)         | (2)      | (3)       | (4)       | (5)      | (6)      | (7)       |  |
| <hr/>                                      |             |          |           |           |          |          |           |  |
| <u>Annual Equivalent</u>                   |             |          |           |           |          |          |           |  |
| <u>Costs 1/</u>                            |             |          |           |           |          |          |           |  |
| Dam & Reservoir <sup>2/</sup>              | \$44,200    | \$46,100 | \$ 90,300 | \$5,800   | \$44,200 | \$51,900 | \$ 96,100 |  |
| Dist. System                               |             |          |           |           |          |          |           |  |
| Agriculture                                | 15,900      | 16,500   | 32,400    | ---       | 15,900   | 16,500   | 32,400    |  |
| Domestic                                   | ---         | ---      | ---       | 2,100     | ---      | 2,100    | 2,100     |  |
| <hr/>                                      |             |          |           |           |          |          |           |  |
| Total Annual<br>Equivalent Cost            | \$60,100    | \$62,600 | \$122,700 | \$7,900   | \$60,100 | \$70,500 | \$130,600 |  |
| <hr/>                                      |             |          |           |           |          |          |           |  |
| <u>Annual Operation and</u>                |             |          |           |           |          |          |           |  |
| <u>Maintenance Costs</u>                   |             |          |           |           |          |          |           |  |
| Dam & Reservoir <sup>2/</sup>              | ---         | 2,100    | 2,100     | 100       | ---      | 2,200    | 2,200     |  |
| Dist. System                               |             |          |           |           |          |          |           |  |
| Agriculture                                | ---         | 9,500    | 9,500     | ---       | ---      | 9,500    | 9,500     |  |
| Domestic                                   | ---         | ---      | ---       | 700       | ---      | 700      | 700       |  |
| <hr/>                                      |             |          |           |           |          |          |           |  |
| Total Operation<br>and Maintenance<br>Cost | ---         | \$11,600 | \$11,600  | \$ 800    | ---      | \$12,400 | \$12,400  |  |
| <hr/>                                      |             |          |           |           |          |          |           |  |
| GRAND TOTAL                                | \$60,100    | \$74,200 | \$134,300 | \$8,700   | \$60,100 | \$82,900 | \$143,000 |  |

1/ Based upon an interest rate of 3 percent over a 50-year period.  
2/ 94 percent of total cost allocated to agriculture.

The total amount of the allocated capital costs to be repaid by the local interests was computed to be \$1,812,400. In addition, local water users will be required to pay the costs of operating and maintaining the project. The total annual costs to be borne by the local water users is \$82,900.

Sufficient revenue can be obtained during the 50-year repayment period from the sale of project water to cover the reimbursable project costs. Although in actual practice revenue will probably be derived from a combination of water sales and other charges, for the purpose of demonstrating the financial capability of the project the assumption was made that total project revenue would be obtained entirely from water sales. A 50-year repayment schedule, based on a water charge of \$14.25 per acre-foot for irrigation water and \$40.00 per acre-foot for domestic water is included in Appendix F.

### Project Financing

As requested by the local interests, the financial studies for the Dry Creek Project are in accordance with the requirements set forth under Public Law 83-566. A brief description of this law and the steps necessary to obtain authorization for construction are given in Appendix K, "General Description of the Watershed Protection and Flood Prevention Act".

There are, of course, other methods of financing available for water development projects. A general discussion of existing methods for financing water development projects was presented in Bulletin No. 99. A brief summary of this material, describing other possible methods of financing, is presented below. Those methods of financing deemed impracticable

for the Dry Creek Project, such as private financing, state participation, and loans for other than recreation and fish and wildlife facilities are not included.

#### Federal Programs

Public Facility Loans. Public Law 84-345, as amended,<sup>1/</sup> authorizes the Administrator of the United States Housing and Home Finance Administration to purchase securities or make loans to public agencies to finance a project essential to public health and welfare where credit is not otherwise available on reasonable terms. Priority is given to applications of communities of less than 10,000 inhabitants for construction of basic public works for municipal purposes.

In formulating the plan of development for the Dry Creek Project, the projected water needs for domestic use in Middletown were considered to represent a demand for project water. Revenue which could be realized from the sale of this water was used in analyzing financial feasibility. At present, Middletown does not have a municipal waterworks system. Construction of a system by the community will be necessary if domestic water is to be obtained from the project. Financial assistance for construction of this system can probably be obtained under Public Law 84-345.

Small Reclamation Project Act. Public Law 84-984 provides assistance to small irrigation projects. Although the project meets the general requirements, and financing could be obtained under this program, local interests have indicated a preference for an alternative method of financing.

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<sup>1/</sup> 69 Stat. 642-644.

Central Valley Project. The U. S. Bureau of Reclamation will submit a report to Congress in 1965 seeking authorization and appropriations for extension of the West Sacramento Valley Canal Unit, a unit of the federal Central Valley Project. The Bureau, through an agreement with local interests in Lake County, has agreed to include an analysis of a project on Dry Creek to serve Collayomi and Long Valleys in their report. If authorized, the project will be part of the Central Valley Project. Purchase of water would be by contract with the Bureau.

#### State Programs

Grants. Under the Davis-Grunsky Act, grants may be made for that portion of the cost of a dam and reservoir properly allocated to recreation, or to the enhancement of fish and wildlife. Consideration given to obtaining financial assistance by this means and the assumptions made governing these considerations are covered in Chapter V, "Recreation, Fish and Wildlife".



APPENDIX A

RESOLUTION AND STATEMENT

BY

LAKE COUNTY FLOOD CONTROL AND

WATER CONSERVATION DISTRICT



BOARD OF DIRECTORS, COUNTY OF LAKE,  
LAKE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

By Helen M. Bogess  
Deputy Clerk

July 6, 1962

STATEMENT BY THE LAKE COUNTY FLOOD CONTROL  
AND WATER CONSERVATION DISTRICT

TO: California Water Commission

RE: Bulletin 99, Reconnaissance Report on Upper Putah Creek  
Basin Investigation

The Board of Directors of the Lake County Flood Control and Water Conservation District wishes to thank the Commission and the Department of Water Resources for the opportunity to appear and to present its comments on Bulletin 99, "Reconnaissance Report on Upper Putah Creek Basin Investigation".

This report was authorized by the Legislature in 1960. The appropriation of funds to the Department for this investigation was vigorously supported by the Lake County Flood Control and Water Conservation District, as well as by the Napa County Flood Control and Water Conservation District. There was some objection of the appropriation of this money and as a result the total funds available were significantly less than had been requested. We believe the Department has done a highly commendable service in preparing such an excellent report with such a limited budget.

The significance of this report and its importance to the Upper Putah Creek Basin can only be appreciated when the report is read in the light of Decision No. 869 of the State Water Rights Board. In this decision, the Water Rights Board granted permits to the United States Bureau of Reclamation for appropriation of water from Putah Creek for the so-called Solano Project. A major feature of this project is Monticello Dam

and the reservoir which that dam created, now known as Lake Berryessa. In applying for the necessary permits from the State Water Rights Board, the Bureau requested what was, for practical purposes, essentially the full flow of Putah Creek, and without any consideration for future uses of water in the Upper Putah Creek Basin. In issuing the permits, in Decision No. 869, the Water Rights Board granted the amount of water which the Bureau requested:

" . . . subject to depletion of stream flow above Monticello Reservoir not to exceed 33,000 acre feet of water annually . . . provided . . . future appropriations shall be initiated and consummated pursuant to law prior to full beneficial use of water within the project service area under these permits".

The water available for appropriation in the Upper Basin has thus been earmarked to the Bureau, except to the extent that users in the Upper Basin can avail themselves of this depletion allowance within the time allowed. The effect of this decision was that of opening the starting gates at a race track.

We would like to state at this time that this reservation of water for Upper Basin use resulted in major part from the efforts of the Division of Water Resources, predecessor to the Department, and that we are most appreciative of this valuable assistance, for without it no water whatsoever would now be available for appropriation for Upper Basin use. Because of the rather unusual cutoff proviso contained in Decision No. 869, we are deeply concerned that, while water is available today, it may not be available tomorrow. We therefore wish to again express our appreciation for the assistance being provided by the Department in the expediting of projects in this area.

A basic problem facing the residents of the Upper Putah Creek Basin is the determination of the most suitable approach to the development of that water which is available. Many different schemes have been proposed, each with a respectable number of proponents. The result, unfortunately, has been confusion. This report will be of tremendous value to the people of the Upper Basin in determining the projects which are best suited to serve their respective needs. If nothing else is gained from this report, this one point will, in our opinion, justify the investigation to date. Although we have not yet had the opportunity to assimilate all of the information contained in the report, we know there is much of value in it beyond the point just mentioned.

Turning to the subject of particular interest to Lake County, we would like to discuss the so-called Dry Creek Project near Middletown. The construction of the dam on Dry Creek, for the purpose of supplying water to the agricultural lands in the vicinity of Middletown, has been under study by Lake County interests for a considerable period of time. The people of the area created, some 3 or 4 years ago, the Middletown County Water District for the purpose of developing and distributing a supplemental water supply for irrigation purposes within the boundaries of the District. That District has, for some time, been cooperating with the Lake County Flood Control and Water Conservation District in studies leading to a Public Law 984 Project. Considerable exchange of information has occurred and the District hopes to complete a feasibility report acceptable to the Bureau of Reclamation, as the administering agency of P. L. 984, in the near future. A major deterrent to the early

completion of this report is the low assessed valuation of the District and the resultant need for moderation in expending funds for planning.

The original planning schedule adopted by the Middletown District and by the Lake County Flood Control and Water Conservation District was developed considering the availability of funds and the need for deliberate speed in developing water. The necessity of greater speed in this regard is emphasized by the position taken by the United States Bureau of Reclamation at the hearing before the State Water Rights Board (January 1962) of its application (No. 19934) to appropriate water to serve the recreational area abutting Lake Berryessa. It there asserted that the word "depletion", as used in Decision 869 respecting the conditional allowance to the Upper Basin, means "gross diversion". (The State Water Rights Board has not yet rendered its decision on that application and, indeed, its decision may not reach this point of definition.) While we believe that the Bureau's assertion flies squarely in the face of the language and intent of that decision and the position consistently taken by the Department of Water Resources in its interpretation of that decision (as most recently expressed in this Bulletin No. 99), it does highlight the critical competition for the water of Putah Creek and, accordingly, the necessity - from our standpoint - of expediting the completion of projects to put water to beneficial use in the Upper Watershed. For this reason we have actively supported the Department's request for an appropriation of additional funds to conduct more detailed investigations of specific projects in the Upper Basin. These funds were appropriated by the 1962 Legislature.

We wish to call your attention particularly to Recommendation No. 1 set forth in Bulletin 99 at p. 253. We most heartily agree with this recommendation. We suggest at this point that the Department, insofar as Lake County is concerned, consider (i) the geologic and soil exploration of the recommended site on Dry Creek and (ii) the determination of the recreational potential of that site. We would hope that such studies could lead to an interim report setting forth the conclusions of the Department by early 1963. It is our opinion that these two phases of a feasibility investigation are well within the capability of the Department but are beyond the capability of the local District at this time.

We again thank you for the opportunity of appearing and being heard in this matter.

APPENDIX B

PART A - GENERAL INFORMATION ON EXISTING  
LOCAL DISTRICTS

PART B - SYNOPSIS OF RIGHTS AND DUTIES  
OF LOCAL WATER DISTRICTS



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PART A - GENERAL INFORMATION ON  
EXISTING LOCAL DISTRICTS

Lake County Flood Control and Water Conservation District

This District was created in 1951 by enactment of the Lake County Flood Control and Water Conservation District Act (Calif. Stat. 1951, Ch. 1544, p. 3522). The District, which is a county-wide organization, was formed to provide flood control and conservation of all waters in Lake County. The affairs of the District are administered by a Board of Directors consisting of five members who are appointed by and serve at the pleasure of the County Board of Supervisors. District business is handled by a full time manager who is appointed by the Directors and responsible to them for compliance with and fulfillment of district policies.

The District has the power to establish water projects to accomplish sanctioned flood control and water conservation goals and is authorized to cooperate with federal agencies for this purpose.

Projects are initiated by the investigation of and reports to the Board of Supervisors on specific water problems. If adopted by the Board of Supervisors, the projects are authorized, unless a written protest is received from a majority of landholders who own one-half or more of the assessed valuation of real property within the area affected.

Special zones can be established to meet the specific needs of an area for project construction or bonding purposes or both. These special zones, however, may not include land within a city unless the city concurs.

Zone 2, a special zone, was established in 1954 for the purpose of furthering studies of the Dry Creek Project. The zone encompasses all of Collayomi and Long Valleys and includes the town of Middletown. After the zone was organized, and additional studies were made, it was concluded that an agency having greater flexibility in handling the problems associated with water resources development should be formed. The Middletown County Water District was subsequently organized and the water rights held by Zone 2 were assigned to the Middletown County Water District.

The District's status concerning the project can be briefly summarized as follows:

1. The Lake County Flood Control and Water Conservation District is legally and financially capable of constructing and operating the Dry Creek Project.
2. Interest has been shown, both at the District or county level and the local level, in the construction and operation of a project of this type.

A synopsis of the Lake County Flood Control and Water Conservation District Act is given in Part B of Appendix B. Part B includes detailed information concerning the type of assessment allowed, bonded indebtedness, inclusion and exclusion of land, and general operating rules.

#### Middletown County Water District

The Middletown County Water District (MCWD) was formed in 1959 under the provisions of the County Water District Law (Division 12 of the Water Code). Its boundaries encompass about 56 percent of the irrigable

area in Collayomi and Long Valleys. Interest has been expressed by many of the remaining landholders in joining the District.

Of the local districts that have the legal capability to construct and operate a water development project on Dry Creek, MCWD has the most extensive powers and purposes. In the event another agency should construct the project, this District could act as a contracting agency for its members.

The District was formed for the specific purpose of furthering development of the Dry Creek Project. This interest is still active as can be evidenced by the frequent contacts by the District members with Department of Water Resources personnel.

A synopsis of the County Water District Law is given in Part B of Appendix B. Part B contains detailed information concerning the powers, limitations, and purposes of the District.

#### Middletown County Waterworks District No. 5

The District was organized in 1947 under the County Waterworks District Act (Calif. Stat. 1913, Ch. 370, p. 785) which was codified in 1953 as the County Waterworks District Law (Division 16 of the Water Code). It was established for the specific purpose of developing a municipal water supply and distribution system for the community of Middletown.

Shortly after the District was formed, an election was held on a bond issue to provide funds for the construction of the required facilities. Due to the narrow margin by which the bond issue was passed, no action was taken by the District on the construction of the facilities.

The District is presently inactive, but can be reactivated rapidly if and when the need arises. It has the legal capability to function as the responsible agency in contracting, treating, and distributing project water for Middletown.

A synopsis of the County Waterworks District Law is given in Part B of Appendix B. Part B includes detailed information concerning the legal capabilities of an organization of this type.

#### East Lake Soil Conservation District

The Middletown Soil Conservation District was deactivated in 1961 and the whole of Lake County reorganized into two soil conservation districts. These are the Westlake Soil Conservation District and the East Lake Soil Conservation District. Collayomi Valley and Long Valley are located in the East Lake Soil Conservation District.

Soil conservation districts are formed under Division 9 of the Public Resources Code and have the legal capabilities of constructing and operating water resource development projects such as the Dry Creek Project.

The East Lake Soil Conservation District is an active organization, headquartered in the Middletown area. A summary of the legal capabilities of an organization of this type is included in Part B of Appendix B.

PART B - SYNOPSIS OF RIGHTS AND DUTIES  
OF LOCAL WATER DISTRICTS

Lake County Flood Control and Water Conservation District

| <u>Item</u>                                    | <u>Remarks</u>   |
|--|--|
| <u>Citation</u>                                | Lake County Flood Control and Water Conservation District Act (Calif. Stats. 1951, Ch. 1544, p. 3522, as amended).   |
| <u>Purposes</u>                                | Provide for the control and impounding of the flood and storm waters of the district, the conservation of all waters within the district, the control of storm and flood waters of streams which flow into the district, protect from such flood or storm waters the watercourse, watersheds, harbors, public highways, life and property in the district, and develop all waters within the district for all beneficial uses.   |
| <u>Territory</u>                               | All of Lake County, cities must concur in establishment of zones which include land within such cities.  |
| <u>Overlap</u>                                 | Zones may be established without reference to boundaries of other zones; act does not preclude any other political subdivision within the district from exercising its powers, nor affect power of any existing city and county or municipal utility district to provide a water supply.   |
| <u>Voting</u>                                  | Qualified electors (registered voters).  |
| <u>Government<br/>Code Sec-<br/>tion 54900</u> | Compliance required upon creation of any zone.   |
| <u>Governing<br/>Body</u>                      | Board of Supervisors of Lake County may delegate any or all of its powers to a commission of 9 members appointed by and serving at the pleasure of the board.  |
| <u>Eminent<br/>Domain</u>                      | Any property within or, with the consent of governing board of the county affected, without district necessary or proper to carry out objects or purposes of the act and convenient to full exercise of powers; if already devoted to public use, court must find that the taking is for a more necessary use; must pay for relocation or removal of public utilities; may condemn existing flood control works; may condemn property to exchange for property devoted to public use or for relocation of such property. |
| <u>State and<br/>Federal<br/>Cooperation</u>   | Cooperate and act in conjunction with the State or the U. S. in construction of works; contract with the State or the U. S. for joint acquisition, construction, use, and disposition of works.  |

Lake County Flood Control and Water Conservation District (continued)

| <u>Item</u>                            | <u>Remarks</u>   |
|--|--|
| <u>Debt Segregation</u>                | Zones may be established for assessment and bonding purposes.  |
| <u>Bonds</u>                           | General obligation, by 2/3 vote in the zone or zones affected; no zone liable for share of bonded indebtedness of any other zone; revenue bonds by majority vote pursuant to the Revenue Bond Law of 1941.   |
| <u>Revenues</u>                        | Sales, leases of property.   |
| <u>Assessments</u>                     | Annual ad valorem upon all real property in the district to pay general administrative costs and to carry out purposes of common benefit to the district, not to exceed 50¢ on each \$100 assessed valuation; annual ad valorem upon all real property in each zone or zones for works benefiting such zones; assessments according to benefits upon all real property in any zone for purposes or works of special benefit to such zone; special assessments upon real property in any zone to pay for works constructed under contract by a governmental body. Annual ad valorem upon all real property in any zone for which bonds have been issued, to pay bonded indebtedness as it becomes due. May levy assessments in zones according to benefits to pay operation and maintenance costs of works for such zones constructed by the State or the United States. Total assessments levied on real property within any zone exclusive of bond taxes shall not exceed \$1.50 of each \$100 of assessed value. |
| <u>Taxation of District Properties</u> | No provision.  |
| <u>Districts Securities Commission</u> | Financial supervision and bond certification approval under Districts Securities Commission Law if requested (Water Code, Section 20003); but bonds are declared by law to be legal investments.   |
| <u>Department of Water Resources</u>   | Investigate under Districts Securities Commission Law if requested.  |
| <u>Inclusion Exclusion</u>             | Inclusion: no provision. Zones may be established from time to time.<br>Exclusion: any chartered or incorporated city may withdraw from district upon majority vote at an election in any such city.   |

Lake County Flood Control and Water Conservation District (continued)

| <u>Item</u>                    | <u>Remarks</u>   |
|--------------------------------|--|
| <u>Disso-</u><br><u>lution</u> | No provision.  |
| <u>Projects</u>                | Instituted by engineering investigation and report and by adoption of project, resolution of intention, notice, and hearing, by the Board; Board may not proceed if written protests filed by a majority in number of holders of real property owning one-half or more of the assessed valuation of real property within the zone or zones affected. |

County Water Districts

| <u>Item</u>                          | <u>Remarks</u>  |
|--------------------------------------|---|
| <u>Citation</u>                      | County Water District Law, Water Code Division 12, comprising Sections 30000-33901.   |
| <u>Purposes</u>                      | Furnish water for any present or future beneficial use; store and conserve water, acquire water rights, and operate works to supply or make use of water for any beneficial use; salvage sewage and storm waters; generate and sell at whole-sale incidental hydroelectric power; acquire and operate sewer facilities; sell or lease oil or mineral rights; in cooperation with U. S. acquire and operate works for irrigation, or development of power and provide recreational facilities; own and operate fire-fighting equipment; drain and reclaim lands; acquire, conserve or dispose of flood and storm water; districts declared public agencies of the State. |
| <u>Territory</u>                     | County, two or more contiguous counties, or any portion.  |
| <u>Overlap</u>                       | Lands in district in existence not less than 5 years and not furnishing water may be included in irrigation districts; a district may be annexed to or included within a municipal utility district without impairing legal existence; may overlap irrigation district; no agency with substantial identity of purpose may be formed in district without consent of district; services of publicly owned utilities within district are subject to restrictions.   |
| <u>Petitioners</u>                   | Voters in district equal to 10% of registered voters in each incorporated area and in the unincorporated area.  |
| <u>Petition to</u>                   | Board of Supervisors of county in which greater portion of district located.  |
| <u>Procedure</u>                     | Petition, hearing, election (majority vote in each municipal corporation or part thereof and in unincorporated territory).  |
| <u>Voting</u>                        | Registered voters, who are residents of the district.   |
| <u>Records</u>                       | Formation, inclusion, exclusion, consolidation and dissolution records: County Recorder and Secretary of State; resolution changing name: County Recorder, Districts Securities Commission, Department of Water Resources, and Secretary of State.  |
| <u>Government Code Section 54900</u> | No provision.   |

County Water Districts (continued)

| <u>Item</u>                            | <u>Remarks</u>  |
|--|---|
| <u>Governing Body</u>                  | 5 directors, elected at large or by divisions (must be voters of district or division).   |
| <u>Eminent Domain</u>                  | Proceedings may be brought pursuant to Code of Civil Procedure, Title 7, Part 3 (Section 31044).  |
| <u>State and Federal Cooperation</u>   | May cooperate and contract with the State as to control and distribution of water, and construction and operation of works. May cooperate and contract with U. S. pursuant to Federal reclamation laws and Irrigation District Federal Cooperation Law; may contract with U. S. to supply water to Indian lands in the district.  |
| <u>Debt Segregation</u>                | Improvement districts for bonding and assessment purposes. Revenue bonds. Property purchase agreements pledging the property and revenues therefrom as sole security.   |
| <u>Bonds</u>                           | General obligation, by 2/3 vote; may be confined to improvement districts; refunding, by majority vote; revenue bonds by majority or 2/3 vote; negotiable notes; bonds given same force as municipal bonds.   |
| <u>Revenues</u>                        | Water and sewer rates; operation of works for any beneficial purpose, or for development of power in cooperation with U. S.; oil and mineral sales, leases; sales, leases of property; wholesale rates for hydroelectric power.   |
| <u>Assessments</u>                     | If revenues insufficient, annual ad valorem on all property in district (bond assessments and improvement district assessments only on property in portion of district benefited; also, under alternative procedure, "water tax" for water system only on property in portion of district benefited). Shall assess land only, exclusive of improvements, for debt due U. S. |
| <u>Taxation of District Properties</u> | By inclusion proceeding instituted by the board, a district may annex land in any county containing district territory.   |
| <u>Districts Securities Commission</u> | Financial supervision and bond certification approval under Districts Securities Commission Law if requested (Water Code, Section 20003; Government Code, Section 54433).   |
| <u>Department of Water Resources</u>   | Investigate under Districts Securities Commission Law if made applicable by request; investigate and report on consolidations.  |

County Water Districts (continued)

| <u>Item</u>                          | <u>Remarks</u>   |
|--------------------------------------|--|
| <u>Inclusion</u><br><u>Exclusion</u> | Inclusion: upon petition (not necessary as to public land of the U. S. or land in county in which district territory already situated), hearing and order of Board of Directors, subject to referendum; land need not be contiguous and may be in adjoining county; may be subject to conditions. District owned land within county may be included by board order. Special provisions for the inclusion of uninhabited lands. Consolidations provided. Exclusion: upon petition (or resolution of board) hearing and order of board, subject to referendum, if for best interest of district or land not benefited. Special provisions for excluding land from overlapping districts. |
| <u>Dissolution</u>                   | Voluntary: by petition, hearing, election (60% vote).  |

County Waterworks Districts

| <u>Item</u>                          | <u>Remarks</u>   |
|--------------------------------------|--|
| <u>Citation</u>                      | County Waterworks District Law, Water Code, Division 16, comprising Sections 55000-55991.  |
| <u>Purposes</u>                      | Supply inhabitants of district with water for irrigation, domestic, industrial, or fire protection purposes; acquire and conserve water from any source; treat or reclaim saline water or sewage.  |
| <u>Territory</u>                     | Any unincorporated portion of a county, or the whole or any portion of one or more incorporated cities and contiguous unincorporated territory, and not included in a county irrigation or county waterworks district; may include non-contiguous territory in the same county of not less than 10 acres if single district is more efficient. |
| <u>Overlap</u>                       | Prohibited.  |
| <u>Petitioners</u>                   | 25% of resident freeholders, or 25% of freeholders including 15% of resident freeholders; cost bond required.  |
| <u>Petition to</u>                   | County Board of Supervisors.   |
| <u>Procedure</u>                     | Petition, hearing, election (majority vote). Election not required if petition signed by all the landowners and no protests filed or other cause found for denying petition.   |
| <u>Voting</u>                        | Registered voters.   |
| <u>Records</u>                       | Orders of formation or inclusion entered on minutes of governing board. Dissolution or withdrawal resolution by City: Board of Equalization, county assessor. Records of formation, inclusion, dissolution, withdrawal, and consolidation: Secretary of State.   |
| <u>Government Code Section 54900</u> | Made specifically applicable to consolidations.  |
| <u>Governing Body</u>                | County Board of Supervisors or 5 directors (voters and landholders) appointed by Board of Supervisors upon petition and hearing. Directors may be appointed at time of formation if requested in formation petition.   |

County Waterworks Districts (continued)

| <u>Item</u>                            | <u>Remarks</u>  |
|--|---|
| <u>Eminent Domain</u>                  | Power not specifically granted; petition for formation shall contain a description of the proposed improvement, including acquisition "by purchase, condemnation, contract, lease, or otherwise" of lands, rights of way and water rights necessary or convenient for proposed works. |
| <u>State and Federal Cooperation</u>   | No specific provision.  |
| <u>Debt Segregation</u>                | Improvement districts, called special zones, for bonding purposes or for fixing rates and charges. Improvement districts pursuant to Improvement Act of 1911. If new territory added, district bonds may be made chargeable solely to new territory.                                  |
| <u>Bonds</u>                           | General obligation, by majority vote; 60% vote in zone for zone bonds; refunding bonds by majority vote; revenue bonds by majority vote; bonds have same force as municipal bonds.  |
| <u>Revenues</u>                        | Rates or charges for use and supply of water or water service, lease or sale of property; may borrow from county funds.   |
| <u>Assessments</u>                     | Annual ad valorem upon all taxable property in district sufficient to pay bonds, operation and maintenance costs and loans; at time of formation, assessments may be limited to land. Improvement Act of 1911 made applicable.  |
| <u>Taxation of District Property</u>   | No provision; but see "Inclusion."  |
| <u>Districts Securities Commission</u> | Financial supervision and bond certification approval under Districts Securities Commission Law if requested (Water Code, Section 20003; Government Code, Section 54433).   |
| <u>Department of Water Resources</u>   | Investigate and supervise under Districts Securities Commission Law if made applicable by request.  |

County Waterworks Districts (continued)

| <u>Item</u>                          | <u>Remarks</u>   |
|--------------------------------------|--|
| <u>Inclusion</u><br><u>Exclusion</u> | <p>Inclusion: Any unincorporated or incorporated territory of a county (including uninhabited land and noncontiguous territory in the same county of not less than 10 acres), if for best interests of district and more efficient than formation of a separate district, upon notice of intention to circulate a petition, petition, hearing, and election (majority vote both in existing district and in new territory; election not required in some instances); inclusion may be made contingent upon voting bond issue or creating special zone at same election; bonds may be chargeable solely to the new territory. Consolidation of two or more districts in same county; need not be contiguous. By agreement, two or more districts may consolidate for operational purposes.</p> <p>Exclusion: Any portion of district which becomes part of a city and for which no bonds have been issued or works provided may be withdrawn from the district by the city upon filing maps and resolution; territory may also be excluded in the same manner as for exclusion from irrigation districts.</p> |
| <u>Dissolution</u>                   | <p>Voluntary: petition, hearing and order of the governing board. Upon dissolution, property of district may be conveyed to any municipal or other public corporation (s) or district (s) authorized to own or operate a water system and which includes 3/4 of territory of district. Districts may be dissolved by annexation or incorporation with a municipal corporation.</p>   |

Soil Conservation Districts

| <u>Item</u>                                    | <u>Remarks</u>   |
|--|--|
| <u>Citation</u>                                | Public Resources Code Division 9, comprising Sections 9000-9953.   |
| <u>Purposes</u>                                | Control runoff, prevent and control soil erosion, develop and distribute water (but not for power), improve land capabilities.   |
| <u>Territory</u>                               | Publicly or privately owned agricultural and other lands, in one or more counties, susceptible of the same general plan or system for accomplishing the purposes of the act; need not be contiguous.   |
| <u>Overlap</u>                                 | Prohibited.  |
| <u>Petitioners</u>                             | 100 landowners (or a majority if less than 200 in proposed area); or a majority of landowners owning a majority of private lands.  |
| <u>Petition to</u>                             | Board of Supervisors of principal county of district.  |
| <u>Procedure</u>                               | Review of proposal by Chief of the Division of Soil Conservation, County Boundary Commission, and Board of Supervisors; petition, hearing, election (not required if petition signed by a majority of landowners owning a majority of private lands), majority vote. |
| <u>Voting</u>                                  | Landowners of the district.  |
| <u>Records</u>                                 | Formation, inclusion, consolidation, partition, change of name, transfer of land: Secretary of State, State Board of Equalization, Chief of Division of Soil Conservation, and county recorder (except formation order).   |
| <u>Government<br/>Code Sec-<br/>tion 54900</u> | No provision.  |
| <u>Governing<br/>Body</u>                      | 5 directors, elected at large (must own land in district or be a resident agent of landowner).   |
| <u>Eminent<br/>Domain</u>                      | No provision.  |

Soil Conservation Districts (continued)

| <u>Item</u>                            | <u>Remarks</u>   |
|--|--|
| <u>State and Federal Cooperation</u>   | May cooperate and contract with the State and the U. S. in furtherance of the provisions of Public Resources Code, Div. 9; accept contributions from, operate and maintain works in cooperation with, and take over or manage projects undertaken by the State or the U. S. Provide local cooperation for watershed protection and flood prevention projects. State may rent or sell equipment and machinery and make grants to the districts. |
| <u>Debt Segregation</u>                | Improvement districts for assessment purposes (for watershed projects).  |
| <u>Bonds</u>                           | May not incur indebtedness in excess of money available, except for loans or revenue bonds secured solely by assets acquired by such loans or bonds. May issue interest-bearing warrants secured by improvement district assessments.  |
| <u>Revenues</u>                        | Gifts and grants; sales, leases of property; charges for water and other services furnished by improvement district works.   |
| <u>Assessments</u>                     | Annual ad valorem on land exclusive of improvements and mineral rights not to exceed 2¢ on each \$100 assessed valuation, for district purposes. Improvement district assessments on land in improvement district, apportioned according to assessed value, for cost of improvements; may be made payable in not more than 10 annual installments.   |
| <u>Taxation of District Properties</u> | No provision.  |
| <u>Districts Securities Commission</u> | No provision.  |
| <u>Department of Water Resources</u>   | Director is member of State Soil Conservation Advisory Board.  |

Soil Conservation Districts (continued)

| <u>Item</u>                          | <u>Remarks</u>  |
|--------------------------------------|---|
| <u>Inclusion</u><br><u>Exclusion</u> | Inclusion: After review of proposal: petition to district board by a majority of landowners owning a majority of acreage, hearing, order of the board; or, petition to Board of Supervisors by 25 landowners (or a majority if less than 50), hearing, election, majority vote; inclusion of contiguous land upon proposal by owners to the district board, review, order of the board; if "ultimate boundaries" established; as to land within such boundaries, petition to and order of district board. Exclusion: Subdivided land, upon joint action of Board of Directors and Board of Supervisors. Consolidation, partition, and land transfer provided. |
| <u>Dissolution</u>                   | Voluntary: petition to Board of Supervisors, hearing, election, 51% of votes cast.  |

APPENDIX C

WATER QUALITY CRITERIA

FOR THE

DRY CREEK PROJECT



Introduction

Criteria presented in this appendix are those commonly employed by the Department of Water Resources in evaluating the quality of water relative to existing or anticipated beneficial uses. It should be pointed out that these criteria are merely guides to the establishment of suitable limits.

Domestic and Municipal Water Supply

Chapter 7 of the California Health and Safety Code contains provisions relating to domestic water supply and refers to drinking water standards promulgated by the United States Public Health Service for water used on interstate carriers. These criteria have been adopted by the State of California. The following is an extract from a report published by the USPHS entitled "Drinking Water Standards, 1962".

"5.2 Limits. - Drinking water shall not contain impurities in concentrations which may be hazardous to the health of the consumers. It should not be excessively corrosive to the water supply system. Substances used in its treatment shall not remain in the water in concentrations greater than required by good practice. Substances which may have deleterious physiological effect, or for which physiological effects are not known, shall not be introduced into the system in a manner which would permit them to reach the consumer.

"5.21 The following chemical substances should not be present in a water supply in excess of the listed concentrations where, in the judgment of the Reporting Agency and the Certifying Authority, other more suitable supplies are or can be made available.

| Substance  | Concentration<br>in mg/l |
|--|--------------------------|
| Alkyl Benzene Sulfonate (ABS) . . . . .            | 0.5                      |
| Arsenic (As) . . . . .                             | 0.01                     |
| Chloride (Cl) . . . . .                            | 250.                     |
| Copper (Cu) . . . . .                              | 1.                       |
| Carbon Chloroform Extract (CCE) . . . . .          | 0.2                      |
| Cyanide (CN) . . . . .                             | 0.01                     |
| Fluoride (F) . . . . .                             | (See 5.23)               |
| Iron (Fe) . . . . .                                | 0.3                      |
| Manganese (Mn) . . . . .                           | 0.05                     |
| Nitrate <sup>1/</sup> (NO <sub>3</sub> ) . . . . . | 45.                      |
| Phenols . . . . .                                  | 0.001                    |
| Sulfate (SO <sub>4</sub> ) . . . . .               | 250.                     |
| Total Dissolved Solids . . . . .                   | 500.                     |
| Zinc (Zn) . . . . .                                | 5.                       |

1/ In areas in which the nitrate content of water is known to be in excess of the listed concentration, the public should be warned of the potential dangers of using the water for infant feeding.

"5.22 The presence of the following substances in excess of the concentrations listed shall constitute grounds for rejection of the supply.

| Substance   | Concentration<br>in mg/l |
|---|--------------------------|
| Arsenic (As) . . . . .                              | 0.05                     |
| Barium (Ba) . . . . .                               | 1.0                      |
| Cadmium (Cd) . . . . .                              | 0.01                     |
| Chromium (Hexavalent) (Cr <sup>+6</sup> ) . . . . . | 0.05                     |
| Cyanide (CN) . . . . .                              | 0.2                      |
| Fluoride (F) . . . . .                              | (See 5.23)               |
| Lead (Pb) . . . . .                                 | 0.05                     |
| Selenium (Se) . . . . .                             | 0.01                     |
| Silver (Ag) . . . . .                               | 0.05                     |

"5.23 Fluoride. - When fluoride is naturally present in drinking water, the concentration should not average more than the appropriate upper limit in Table 1. Presence of fluoride in average concentrations greater than two times the optimum values in Table 1 shall constitute grounds for rejection of the supply.

Where fluoridation (supplementation of fluoride in drinking water) is practiced, the average fluoride concentration shall be kept within the upper and lower control limits in Table 1.

TABLE 1

| Annual average of maximum daily air temperatures <sup>1/</sup> | : Recommended control limits--<br>: Fluoride concentrations in mg/l |           |         |
|--|---|-----------|---------|
|  | : Lower   | : Optimum | : Upper |
| 50.0-53.7  | 0.9   | 1.2       | 1.7     |
| 53.8-58.3  | 0.8   | 1.1       | 1.5     |
| 58.4-63.8  | 0.8   | 1.0       | 1.3     |
| 63.9-70.6  | 0.7   | 0.9       | 1.2     |
| 70.7-79.2  | 0.7   | 0.8       | 1.0     |
| 79.3-90.5  | 0.6   | 0.7       | 0.8     |

1/ Based on temperature data obtained for a minimum of five years."

In addition, the 1962 Standards give the following information on the physical characteristics for drinking water.

"4.2 Limits. - Drinking water should contain no impurity which would cause offense to the sense of sight, taste, or smell. Under general use, the following limits should not be exceeded:

|                           |          |
|---------------------------|----------|
| Turbidity . . . . .       | 5 units  |
| Color . . . . .           | 15 units |
| Threshold Odor Number . . | 3"       |

#### Irrigation Water

Because of the diverse climatological conditions for crops, soils, and irrigation practices in California, criteria which may be set up to evaluate the suitability of water for irrigation use must necessarily be of a general nature, and judgment must be used in their application to individual cases. Suggested limiting values for total dissolved solids, chloride concentration, percent sodium, and boron concentration for three general classes of irrigation water are shown in Table C-1.

Preservation and Protection of Fish and Wildlife

A healthy and diversified aquatic population is indicative of good water quality conditions which, in turn, permit optimum beneficial uses of the water. For such a population to exist, the environment must be suitable for both the fish and the food-chain organisms.

Many mineral and organic substances, even in low concentrations, are harmful to fish and aquatic life. Insecticides, herbicides, ether-soluble materials, and salts of heavy metals are of particular concern. It may be noted that although the drinking water standards permit as much as 1.0 and 5.0 mg/l of copper and zinc, respectively, such levels are generally toxic to fish.

It has been found that fish can thrive between pH limits of 6.5 to 8.5.

TABLE C-1

## QUALITATIVE CLASSIFICATION OF IRRIGATION WATERS

|                     | Class 1       | Class 2         | Class 3        |
|---------------------|---------------|-----------------|----------------|
|                     | Excellent     | Good to         | Injurious to   |
|                     | to good       | injurious       | unsatisfactory |
|                     | (Suitable for | (Possibly harm- | (Harmful to    |
|                     | most plants   | ful for some    | most crops and |
| Chemical properties | under any     | crops under     | unsatisfactory |
|                     | conditions of | certain soil    | for all but    |
|                     | soil and cli- | conditions)     | the most       |
|                     | mate)         |                 | tolerant)      |

## Total dissolved solids:

|                     |                 |               |                 |
|---------------------|-----------------|---------------|-----------------|
| In ppm              | Less than 700   | 700 - 2,000   | More than 2,000 |
| In conductance      |                 |               |                 |
| micromhos at 25° C. | Less than 1,000 | 1,000 - 3,000 | More than 3,000 |

## Chloride ion concentration:

|                     |               |           |               |
|---------------------|---------------|-----------|---------------|
| In milliequivalents |               |           |               |
| per liter           | Less than 5   | 5 - 10    | More than 10  |
| In ppm              | Less than 175 | 175 - 350 | More than 350 |

|                           |               |           |               |
|---------------------------|---------------|-----------|---------------|
| Sodium in percent of base |               |           |               |
| constituents              | Less than 60  | 60 - 75   | More than 75  |
| Boron in ppm              | Less than 0.5 | 0.5 - 2.0 | More than 2.0 |



APPENDIX D

EXTRACTS FROM

DEPARTMENT OF WATER RESOURCES

STANDARD LAND CLASSIFICATION AND LAND USE LEGEND



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| Symbol: | Characteristics |
|---------|-----------------|
|---------|-----------------|

STANDARD LAND CLASSIFICATION LEGEND 1/Irrigable Lands

- V These lands are level or slightly sloping and vary from smooth to hummocky or gently undulating relief. The maximum allowable slope is 6 per cent for smooth, reasonably large-sized bodies lying in the same plane. As the relief increases and becomes more complex, lesser slopes are limiting. The soils have medium to deep effective root zones, are permeable throughout, and free of salinity, alkalinity, rock, or other conditions limiting crop adaptability of the land. These lands are suitable for all climatically adapted crops.
- H These are lands with greater slope and/or relief than those of the V class. They vary from smooth to moderately rolling or undulating relief. The maximum allowable slope is 20 per cent for smooth, reasonably large-sized bodies lying in the same plane. As the relief increases and becomes more complex, lesser slopes are limiting. The soils are permeable, with medium to deep effective root zones, and are suitable for the production of all climatically adapted crops. The only limitation is that imposed by topographic conditions.
- M These are lands with greater slope and/or relief than those of the H class. They vary from smooth to steeply rolling or undulating relief. The maximum allowable slope is 30 per cent for smooth, reasonably large-sized bodies lying in the same plane. As the relief increases and becomes more complex, lesser slopes are limiting. The soils are permeable, with medium to deep effective root zones, and are suitable for the production of all climatically adapted crops. The only limitation is that imposed by topographic conditions.
- (The foregoing may be modified, as conditions warrant, by use of one or more of the following symbols.)
- p Indicates shallow depth of the effective root zone, which in general limits use of these lands to shallow-rooted crops.
- h Indicates fine textures, which in general make these lands best suited for the production of shallow-rooted crops.

---

| Symbol: | Characteristics |
|---------|-----------------|
|---------|-----------------|

---

Urban and Recreation Lands

- |    |  |
|----|--|
| UD | The total area of cities, towns, and small communities presently used for residential, commercial, recreational, and industrial purposes.      |
| RC | Existing and potential commercial areas which occur within a primarily recreation area and which include motels, resorts, hotels, stores, etc. |
| RT | Existing and potential camp and trailer sites within a primarily recreation area.  |

Miscellaneous Lands

- |   |  |
|---|--|
| N | Includes all lands which fail to meet the requirements of the above classes. |
|---|--|

STANDARD LAND USE LEGEND 1/

Agricultural Classes

- |   |  |
|---|--|
| V | Vineyards                                      |
| G | Grain and Hay Crops                            |
| P | Pasture  |
| F | Field Crops                                    |
| T | Truck and Berry Crops                          |
| D | Deciduous Fruits and Nuts                      |
| I | Idle   |
| S | Semiagricultural and Incidental to Agriculture |

Urban Classes

- |   |   |
|---|---|
| U | Urban - residential, commercial, and industrial |
|---|---|

---

| Symbol : | Characteristics |
|----------|-----------------|
|----------|-----------------|

---

Native Classes

|    |                   |
|----|-------------------|
| NV | Native Vegetation |
|----|-------------------|

Additional Symbols

|     |           |
|-----|-----------|
| (i) | Irrigated |
|-----|-----------|

|     |              |
|-----|--------------|
| (n) | Nonirrigated |
|-----|--------------|

---

1/ Only those land classification and land use symbols used in mapping the area of investigation are included.



APPENDIX E

ENGINEERING GEOLOGY

OF

COLLAYOMI DAM AND RESERVOIR



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## Introduction

### Location

Collayomi Dam and Reservoir will be located in Lake County, on Dry Creek, a tributary to Putah Creek. The proposed axis is in the SW $\frac{1}{4}$  of Section 4 and the NW $\frac{1}{4}$  of Section 9, T10N, R7W, MDB&M, approximately 2 miles southwest of Middletown. Access is by the Dry Creek Road which parallels Dry Creek and crosses the damsite.

### Scope

Beginning in October 1962, and continuing at intervals until June 1963, a geologic investigation was conducted for the proposed Collayomi Dam, an earthfill structure about 130 feet in height. The program consisted of surface mapping, borrow area and foundation drilling, laboratory soil testing, and seismic surveys.

### Previous Investigations and Reports

This general area has been the subject of several geologic reports. The more important of these are listed below:

Bailey, E. H., "Quicksilver Deposits of the Mayacmas District". California Journal of Mines and Geology. Vol. 42, No. 3. July 1946.

Brice, J. C. "Lower Lake Quadrangle". California Division of Mines. Bulletin 166. 1953.

Ford, R. S. "Reconnaissance Outline on Geology of Upper Dry Creek Damsite". California Department of Water Resources. Office Report. January 1961.

Collayomi damsite and adjacent areas are covered by the USGS 15-minute Calistoga and Lower Lake quadrangles, scale of 1:62,500, with a contour interval of 80 feet, and the 7 $\frac{1}{2}$ -minute Mt. St. Helena quadrangle, scale of 1:24,000, with a contour interval of 40 feet.

The California Department of Water Resources Maps and Surveys Branch made a map of the damsite and reservoir area to a scale of 1:3,600 with a contour interval of 10 feet.

### Regional Geology

#### Geomorphology

The area under investigation lies within the northern Coast Ranges geomorphic province. The Coast Ranges consist of several longitudinal mountain ranges having elevations up to 6,000 feet above sea level and are separated by intermontane faults and erosional valleys which ordinarily trend northwesterly.

The area surrounding the Collayomi damsite is dominated by the Mayacmas Mountain Range, which trends northwest-southeast and has an elevation of from 2,000 feet to slightly over 4,000 feet. These mountains are subject to heavy precipitation and are probably in an erosional stage of late youth development with steep slopes and deep narrow canyons. Landslides are common, especially in areas of serpentine and highly sheared Franciscan rocks. Both the steep slopes and landslide areas in the Franciscan Formation are covered with heavy brush and scattered timber.

There are indications of higher stream cut terraces at elevations 50 to 75 feet above the present stream grade. Some of the terraces are strewn with rounded boulders of a rock type different than that comprising the underlying bedrock.

Dry Creek, in its upper reaches within the reservoir area, appears to be stabilized within its bedrock channel. Below the damsite the creek is not confined except by unconsolidated sedimentary deposits and has probably meandered widely in the past.

### Areal Geology

The general geology of the region surrounding Collayomi dam-site is typical of the heterogeneous mixture of rocks found in the northern Coast Ranges.

Underlying the area are rocks of the Jurassic-Cretaceous Franciscan Formation, made up of sandstone, highly sheared shale, chert, and their metamorphic equivalents grading to glaucophane and actinolite schists and greenstone. Overlying the Franciscan rocks near the damsite are Cretaceous sandstone and shale of the Knoxville Formation. Intruded into these units are large irregularly shaped belts and pods of serpentine and serpentinitized ultrabasic rocks. The emplacement of these large bodies of serpentine has nearly destroyed the sedimentary characteristics of the enclosing Franciscan-Knoxville Formations and is responsible for the highly sheared condition of the shaly member.

Overlying and intruded into the older rocks are Tertiary volcanic rocks. The Sonoma volcanics, which are primarily andesitic, predominate in the higher parts of the Mayacmas Mountains, but minor basaltic intrusives occur sporadically throughout the series of formations.

Alluvium and stream gravels are not common except in the lower reaches of the streams and in the Collayomi-Long Valley area.

### Seismicity

The seismicity of the area has been evaluated by the Department of Water Resources and a complete report is available in the Department's files. In summary, this report states that from the viewpoint of seismic activity, Collayomi damsite is located in a relatively quiet area, with

no evidence of active faults within the vicinity of the damsite. The nearest area of active epicenters is along the San Andreas fault, approximately 34 miles to the southwest.

For this stage of planning a 0.1g seismic design factor appears to be adequate for the proposed structure. This value should be verified by use of appropriate seismic instrumentation.

### Geology of the Site

#### Topography

The topography at the site is not particularly steep or rugged. The channel section at the axis is about 550 feet wide with the creek flowing along the left side of the section. From the creek a gentle slope rises toward the right abutment. The abutments have a slope in their upper part of from 25 to 30 degrees. At the axis Dry Creek has a gradient of about 10 feet in 1,000 feet, steepening above the damsite and becoming flatter below. The valley, which will form the reservoir area, widens to about 600 feet above the axis.

The abutments are covered with residual soil which supports a heavy growth of brush and scattered timber. Outcrops are scattered on the abutments, but only in the main channel of Dry Creek and in the minor side streams is bedrock well exposed. Small seeps and springs occur during the wet season from areas of sheared rock and landslides, but these are generally dry in the summer. On the right abutment, immediately downstream from the axis, a large landslide mass is present. Slumping, scarps, and leaning trees indicate that this may be moving in small units at present, though initially it probably moved as a single large mass.

Two holes were drilled to 25 feet each in the landslide mass with no indication of bedrock or rock weathered in place.

### Rock Types

The damsite is underlain by rocks of the Franciscan Formation. The rock types that predominate are sandstone and highly sheared shale that have in part been subject to some metamorphism. Glaucophane and actinolite schists are found in the immediate vicinity of the site. Greenstone occurs as pods and lenses throughout both the metamorphic rocks and the sandstone and shale. These general rock types are intricately faulted against each other with lateral changes in rock type within short distances. The great degree of shearing and faulting within this general area is related to the intrusion of a belt of serpentine, up to 1 mile in width, approximately one-half mile to the west. Minor serpentized zones were found in the mapped area, but no serpentine was found underlying the fill area of the proposed damsite. Plate E-1 shows the geology of the damsite and vicinity.

### Structural Features

The general structure of the area is a series of eastward dipping consolidated sediments. This is, however, very nearly obscured by the great degree of shearing and faulting within the area of the damsite. Intense shearing of the shale obscures all original structure of this rock type. The metasandstone appears to have been badly broken and partially rehealed with quartz, leaving little of its original structure. Schistosity within the glaucophane and actinolite schists generally is in a northerly direction, although in some instances it has been completely masked by recrystallization of the parent schistose rock.

Exploration of Foundation Rock

Three diamond core holes were completed at the damsite during May 1963. Hole RA-R1 was drilled at an angle of 55 degrees (nearly perpendicular to the slope of the hill) into the right abutment. It penetrated 31 feet of weathered material and then entered very highly sheared shale with minor layers of sandstone to a total depth of 60.6 feet. During the drilling, the hole continually caved. Black sand-size shale fragments were found washing from the hole.

Hole RC-R1 was placed in the right channel section. It encountered 7.6 feet of stream sand and boulders, and then entered sheared shale and sandstone. No weathered rock was apparent in this hole; however, the general condition of the rock appeared to be somewhat better than either abutment.

Hole S-R1 was located above the left abutment to coincide with the center line of the end-around spillway and was drilled vertically to a depth of 78.6 feet. At 46 feet unweathered sheared shale and sandstone were encountered.

All three holes were water tested with the rock appearing to be, in general, rather tight. Leakage is not expected to be a problem at this site. The complete log of the drill holes is presented in Figures E-1, E-2, and E-3.

In addition to the drilling program, a geophysical survey was conducted about the damsite and on the proposed impervious borrow areas. The work consisted of seven refractive seismic lines to determine the depth to sound bedrock beneath the dam and spillway and three lines to determine the thickness of the impervious borrow material.

FIGURE E-1

## CALIFORNIA STATE DEPARTMENT OF WATER RESOURCES

## DRILL HOLE LOG

Collayomi Damsite

HOLE NUMBER RA-R1 LOCATION Right Abutment GROUND ELEVATION 1280' ATTITUDE S 8° W., 55°  
 BEGUN May 15, 1963 FINISHED May 23, 1963 CORE RECOVERY 42 percent TOTAL DEPTH 60.6'  
 DEPTH AND ELEVATION OF WATER TABLE \_\_\_\_\_ TYPE HOLE NX DRILLING COMPANY Department of Water Resources  
 DRILL FOREMAN J. Helland TYPE OF RIG QP-8 LOGGED BY D. R. Schnaible

| ELEV.<br>IN<br>FEET | HOLE<br>DEPTH<br>W/ 6128<br>CORE<br>OR<br>HOLE | CORE<br>RECOVERY<br>PERCENT<br>50 100 | GRAPHIC<br>LOG<br>POOR GOOD | ROCK CLASSIFICATION AND PHYSICAL CONDITION   | REMARKS   | WATER TEST                  |     |     |      |      |      |     |     |   |  |
|---------------------|--|---------------------------------------|-----------------------------|--|---|-----------------------------|-----|-----|------|------|------|-----|-----|---|--|
|                     |  |                                       |                             |  |   | GPM<br>PSI<br>LENGTH (MIN.) |     |     |      |      |      |     |     |   |  |
|                     |  |                                       |                             |  |   | TEST NUMBER                 |     |     |      |      |      |     |     |   |  |
|                     |  |                                       |                             |  |   | 1                           | 2   | 3   | 4    | 5    | 6    | 7   | 8   | 9 |  |
| 0                   |  |                                       |                             | <u>METASEDIMENT (Metasandstone and shale)</u>  | Brown drill return  |                             |     |     |      |      |      |     |     |   |  |
|                     |  |                                       |                             | 0.0 - 11.2: Severely weathered, brown, loose, generally sandy silt, some rock fragments.   | Graybrown return  |                             |     |     |      |      |      |     |     |   |  |
| 10                  |  |                                       |                             | 11.2 - 31.0: Moderately weather and fractured, largely highly sheared shale, fragments soft to firm.   | Drill easy but frequent core blocking.<br>Caving from 18.2' - 20.0'<br>Cased to 20.0' |                             |     |     |      |      |      |     |     |   |  |
| 20                  |  |                                       |                             |  |   |                             |     |     |      |      |      |     |     |   |  |
| 30                  |  |                                       |                             | 31.0 - 60.6: Generally hard; gray; severely jointed, fractured, and sheared; numerous quartz veinlets in sandstone; shale is black and severely sheared. | Gray return<br>Cased to 35.0'   |                             |     |     |      |      |      |     |     |   |  |
| 40                  |  |                                       |                             |  | Cased to 43.7'  |                             |     |     |      |      |      |     |     |   |  |
| 50                  |  |                                       |                             |  |   |                             |     |     |      |      |      |     |     |   |  |
| 60                  |  |                                       |                             |  | 60.6' - End hole.   |                             |     |     |      |      |      |     |     |   |  |
|                     |  |                                       |                             |  |   | 1.3                         | 2.8 | 6.0 | 12.5 | 12.5 | 10.5 | 4.5 | 1.5 |   |  |
|                     |  |                                       |                             |  |   | 20                          | 40  | 60  | 80   | 80   | 60   | 40  | 20  |   |  |
|                     |  |                                       |                             |  |   | 3                           | 3   | 3   | 3    | 5    | 3    | 3   | 3   |   |  |

## CALIFORNIA STATE DEPARTMENT OF WATER RESOURCES

DRILL HOLE LOG  
Collayomi Damsite

HOLE NUMBER RC-R1 LOCATION Right channel GROUND ELEVATION 1180' ATTITUDE Vertical  
 BEGUN May 27, 1963 FINISHED May 30, 1963 CORE RECOVERY 38 percent TOTAL DEPTH 57.7'  
 DEPTH AND ELEVATION OF WATER TABLE \_\_\_\_\_ TYPE HOLE NX DRILLING COMPANY Department of Water Resources  
 DRILL FOREMAN J. Holland TYPE OF RIG CP-8 LOGGED BY D. R. Schmaible

| ELEV.<br>IN<br>FEET | ANGLE<br>DEPTH<br>w/ SIZE<br>CORE<br>OR<br>HOLE | CORE<br>RECOVERY | GRAPHIC<br>LOG | ROCK CLASSIFICATION AND PHYSICAL CONDITION  | REMARKS  | WATER TEST    |   |   |   |   |   |   |   |   |  |
|---------------------|---|------------------|----------------|---|--|---------------|---|---|---|---|---|---|---|---|--|
|                     |   |                  |                |   |  | GPM           |   |   |   |   |   |   |   |   |  |
|                     |   |                  |                |   |  | PSI           |   |   |   |   |   |   |   |   |  |
|                     |   |                  |                |   |  | LENGTH (MIN.) |   |   |   |   |   |   |   |   |  |
|                     |   |                  |                |   |  | TEST NUMBER   |   |   |   |   |   |   |   |   |  |
|                     |   |                  |                |   |  | 1             | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |  |
| 0                   |   |                  |                | <u>STREAM ALLUVIUM</u>  | Drill easy. Rough drill from 3.2' to 7.5'.     |               |   |   |   |   |   |   |   |   |  |
| 10                  |   |                  |                | 0.0 - 3.2: Silty sand, brown, loose   |  |               |   |   |   |   |   |   |   |   |  |
| 20                  |   |                  |                | 3.2 - 7.5: Gravelly sand, cobbles and boulders of greenstone and glaucophane schist.                                    | Light & dark gray drill return. Cased to 11.0' |               |   |   |   |   |   |   |   |   |  |
| 30                  |   |                  |                | <u>7.5</u> <u>METASEDIMENT</u> (Metasandstone and shale)  |  |               |   |   |   |   |   |   |   |   |  |
| 40                  |   |                  |                | 7.5 - 57.7: Generally hard, gray, severely jointed, fractured, and sheared, numerous quartz, veinlets in metasandstone. |  |               |   |   |   |   |   |   |   |   |  |
| 50                  |   |                  |                | At 30.0', fractures $\phi 8^{\circ}$ to $45^{\circ}$ .  |  |               |   |   |   |   |   |   |   |   |  |
| 57.7                |   |                  |                | At 50.0', joints $45^{\circ}$ to $90^{\circ}$ .   |  |               |   |   |   |   |   |   |   |   |  |
|                     |   |                  |                | At 54.0', joints nearly horizontal.   |  |               |   |   |   |   |   |   |   |   |  |

← Leak around packer and casing →

0.1 0.5 45 11 1 3 13 9  
 20 40 60 60 20 40 60 60  
 3 3 3 5 3 3 3 5

CALIFORNIA STATE DEPARTMENT OF WATER RESOURCES

HOLE NUMBER S-RI LOCATION Spillway GROUND ELEVATION 1329 ATTITUDE Vertical  
 BEGUN May 8, 1963 FINISHED May 13, 1963 CORE RECOVERY 63 percent TOTAL DEPTH 78.6'  
 DEPTH AND ELEVATION OF WATER TABLE \_\_\_\_\_ TYPE HOLE IX DRILLING COMPANY Department of Water Resources  
 DRILL FOREMAN J. Holland TYPE OF RIG GP-8 LOGGED BY G. Curtin, D. R. Schaeble

[illegible]

Foundation ConditionsRight Abutment

The right abutment consists of a narrow ridge bounded by an intermittent stream on the upstream edge and a small spring fed stream on the downstream edge. This ridge has a slope of about 30 degrees toward Dry Creek and drops off sharply toward the bounding small streams. The upper stream should flow safely into the reservoir after the dam is completed, but the lower stream should be diverted around the toe of the dam. This abutment is covered with heavy brush and scattered timber.

No outcrops were found on that part of the abutment to be covered by the fill material. Broken chert outcrops were found immediately above the crest of the proposed dam, and greywacke, metasediments, chert, and greenstone were found in the channels of the small streams on either side of the abutment. During bulldozing of a road to the site of drill hole RA-R1, broken and weathered metasediments were exposed in the side-hill cut covered by slope wash and organic material to a depth of 3 to 4 feet.

The core of the drill hole revealed 31 feet of broken and weathered metasediments and then a series of unweathered sheared shale and broken metasandstone. The latter has in part been rehealed with quartz veinlets. The quality of the foundation rock below 31 feet does not improve with depth.

Water tests in the drill hole indicate a low grout take. A grout cap will be necessary, and with a single line grout curtain to 30 feet below the bottom of the cutoff trench, the grout take on 5-foot centers is estimated at one-half to one sack per linear foot.

Stripping Estimate. Stripping on the right abutment should average 4 feet of soil and root zone. An additional 27 feet of weathered rock should be excavated for the cutoff trench up to the elevation of the normal pool of the reservoir. This work can be accomplished by common excavation. All depths are measured normal to the ground surface.

#### Channel Section

The channel section along the axis is approximately 550 feet wide, sloping gently downward from the right abutment to the creek bed bordering the base of the left abutment. Bedrock, partially covered by loose stream gravels, is exposed along the creek bed. Rock types which are exposed include chert, metasediments, and unaltered greywacke sandstone. The toe of the upstream slope of the dam will rest on greywacke sandstone. The greywacke is massive, very hard, has few joints, and should be capable of supporting a structure of this size. Immediately downstream from the greywacke, underlying the axis, are metasediments with chert beds folded and faulted in. The metasediments are similar in character to those on either abutment; sheared shaly beds within more massive metasandstone which form rib-like outcrops in the streambed. The metasediments have a general trend of lineation and shearing in a northwesterly direction striking obliquely across the channel and the axis. The sheared nature of the shaly beds in this sequence of rocks is not expected to cause any large seepage problem since water tests conducted in the channel drill hole RC-R1 indicate that the material is rather tight at the depth tested. Also the nature of shearing in this area seems to be in a nearly vertical attitude. The enclosed chert beds are thin (2 to 4 inches), have widely varying attitudes due to intricate faulting and folding,

and range from fairly massive to highly jointed. The chert does not weather as easily as the enclosing metasediments and forms sporadic outcrops throughout the area. Leakage through the highly jointed portion of the chert should not be a problem as it is believed that the joints do not have any great degree of continuity. The depth and degree of weathering of the bedrock varies from fresh rock in the stream channel and in drill hole RC-R1 to an estimated 30 to 40 feet near the right abutment as determined by seismic exploration.

A stream terrace deposit composed of sand, cobbles, and boulders, with a maximum thickness of 10 feet, covers the bedrock between the creek and the right abutment as a thin veneer. This stream deposit pinches out above the Dry Creek Road and weathered bedrock crops out near the base of the right abutment.

Minor faults were observed in the channel area along the axis, particularly where the various rock types butt against each other, but gouge zones were not observed and rehealing of the faults with silica is the rule rather than the exception. Above the upstream toe of the dam a major fault was uncovered by the bulldozer. This large fault zone, forming the contact between glaucophane schist and massive sandstone, is 15 to 20 feet wide, highly serpentized, and contains talc seams 4 to 6 inches in width. This fault could be of great significance if the dam height were raised or the axis changed so that the fill material reached this area.

Grouting estimates are similar to those of the right abutment, one line of holes on 5-foot centers to a maximum depth of 65 feet below the bottom of the cutoff trench should take one-half to one sack of grout per linear foot.

Stripping Estimate. Stripping in the channel section should average 3 feet of organic soil. Excavation for the cutoff trench will require the removal of a layer of terrace gravels plus a variable thickness of bedrock. For the gravels, which forms a lens extending from near the creekbed to immediately above the Dry Creek Road, an average thickness of 5 feet of material should be removed. Depth of excavation of the bedrock and the terrace gravels will vary from 4 feet of hard rock in the stream channel to 27 feet of weathered rock near the right abutment. The 4 feet of excavation of hard bedrock near the stream channel will require shooting, while the rest of the work can be accomplished by common excavation. Unless the design of the dam is changed, none of the material removed will be usable as fill in the construction of the dam.

#### Left Abutment

The left abutment is formed by a narrow ridge extending outward toward the channel from Long Ridge. A small spur of this ridge extends toward the channel near the lower part of the upstream slope. The ridge is quite narrow and the embankment will spill around both the upstream and downstream slope and over most of the small spur.

The rock conditions, as shown by drill hole S-R1, are similar to those of the right abutment. The bedrock is sheared sandstone and shale with chert lenses and beds that have been deeply weathered. Alteration and replacement products are common in the highly sheared material.

Faulting and shearing are believed to have occurred near the small gully separating the main abutment from the small spur. However, a good portion of the rock mass is so sheared that this should not further

affect construction treatment. Minor slides and slip-outs were found on the downstream edge of the abutment, but these areas should be stable after fill material is placed against them.

Grouting estimates should be similar to that of the right abutment and channel section. One line of holes on 5-foot centers to a depth of 30 feet below the bottom of the cutoff trench should be adequate. It is possible that a grout cap will be required at this abutment. Water test results do not indicate excessive leakage (see water test results for drill hole S-R1).

Stripping Estimate. It is recommended that the abutment be stripped to an average depth of 4 feet to remove the root zone. An additional 36 feet of weathered rock should be excavated for the cutoff trench beneath the dam and spillway sections. This work can be accomplished by common excavation. All depths are measured normal to the ground surface. Since the weathered bedrock received no soils test and its properties remain unknown, it can only be recommended that the excavated material be wasted.

### Spillway

Spillway sites considered in the exploration of this damsite included an end-around channel around the left abutment of the dam and a cut in the saddle where the left abutment ridge joins with Long Ridge. The right abutment was ruled out as a possible location due to the presence of a landslide downstream from the dam axis.

The end-around channel would be founded on the same general rock types as described for the left abutment. Considering the depth of weathering on this slope it is probable that the inner edge of the weir

section would be founded on rock while the outer edge would be founded on weathered material. The bottom of the cutoff trench, therefore, should be excavated down to unweathered rock and backfilled with concrete. The weir structure should be designed so that it would not be affected by differential settlement. It will be necessary to line the spillway chute as the rock is not competent enough to withstand the effect of rapidly moving water. At the discharge end of the spillway channel some type of stilling basin will be needed to control erosion of the stream banks and channel. Cut slopes of 0.50:1 or 0.75:1 in the approach channel and above the spillway walls should be adequate for the rock zones, but within the weathered zone a reduction of slope to at least 1.5:1 is recommended. Since the side hill cut would be quite high, one or more benches will be necessary as well as the installation of horizontal drains.

The other alternate spillway site, in the saddle to the north of the left abutment, would necessitate a larger cut. The rock types encountered would be massive unaltered sandstone, chert, metasediments, and possibly glaucophane schist. Rock excavated from this location may be usable as riprap or rockfill in the dam section. The cut slopes should stand at 0.5:1 and the rock may be sound enough to eliminate lining the chute. A free drop discharge and unlined return to Dry Creek are feasible. The discharge would be returned to the creek farther downstream from the toe of the dam than mentioned in the first alternate. The main factors that would affect this site would be the location, direction, and inclination of the minor faults that would probably be uncovered during excavation.

Outlet Works

It is proposed to construct a cut and cover conduit along the right bank of Dry Creek in the channel section for use as an outlet works. Excavation for the conduit would necessitate the removal of an average of 8 feet of loose terrace material and 2 feet of fairly hard rock. The hard rock will require shooting while the rest of the work could be done by common excavation.

Reservoir Area

The reservoir is underlain by the same varied rock types that form the damsite. These rocks are fractured and jointed, but leakage is not expected to occur from the reservoir. Silting of the reservoir will occur to a minor degree.

Possibilities of landslides occurring within the reservoir area are a factor which was considered. A survey of the area disclosed six slides in the Franciscan Formation within a 2 mile radius of the damsite. Of particular interest were the two slides above Kroll Creek and the large slide immediately downstream from the right abutment, all of which occur on Lindquist Ridge. It was believed that the steep slopes between these old slides had the greatest potential for failure. A geologic reconnaissance of this area along Lindquist Ridge and within the balance of the reservoir area failed to disclose evidence of incipient or old slides such as hummocky topography, leaning trees, slip-outs, or tension cracks. Furthermore, that portion of the surrounding hills which will be wetted by filling the reservoir has slopes shallower than three horizontal to one vertical. It is believed, therefore, that landslides do not present a potential danger to the dam structure.

Present use of the reservoir area is limited to cattle grazing. No active mines are in the reservoir although it is believed that some mineral claims are present. Relocation of existing dirt roads will be necessary to service the mines and local inhabitants. It is estimated that 90 percent of the road construction will involve common excavation.

### Construction Materials

#### General

Sufficient quantities of borrow materials for the construction of the dam are available within economic haul distances. Locations of the proposed borrow areas are outlined on Plate E-2. Twenty-two auger holes were drilled at the damsite and in the impervious borrow areas. Representative samples of impervious borrow materials were sent to the Department of Water Resources' Soils Laboratory for primary and secondary testing. The results of these tests are available in the Department's files. Logs of the auger exploration holes are delineated on Plate E-3.

#### Impervious Material

As a result of the drilling and testing program two main impervious borrow areas were selected. Area 1 should furnish the required volume of impervious fill material; however, Area 2 could be used if more material is needed.

Area 1 is approximately 3,000 feet to the north of the axis on the downstream side of the dam. This borrow area includes an old highly weathered terrace deposit and a deeply weathered zone on the adjoining hill which also contains suitable materials. The material in each case is composed primarily of sandy clay with scattered pebbles. Very little

stripping of overburden would be necessary as the area is generally barren of vegetation. While drilling showed a maximum depth of about 40 feet for the terrace material, it is estimated that all of the 1,240,000 cubic yards of impervious fill required could be obtained from this borrow area within a depth of 20 feet.

Area 2 is 1,000 feet nearer the damsite and similar to that of Area 1, but because it would require the removal of a heavy brush covering and stripping of the root zone, it is only suggested for use as an auxiliary borrow area. Approximately 400,000 cubic yards of impervious material could be obtained from this source.

#### Pervious Material

The pervious material could come from one of two possible sources. One possibility is the stream gravels along Dry Creek downstream from its intersection with the Dry Creek Cutoff Road; the other is the stream gravels from the gravel plant located on Putah Creek near the confluence with Dry Creek.

The gravels along Dry Creek, about 1 mile haul distance from the site, were not considered as a suitable source because the material is not clean, is irregularly sorted in size, and probably of shallow depth. The gravel plant along Putah Creek, which is about 3 air miles from the damsite, could furnish a steady supply of any desired gradation. Total amount of gravel required in the dam is approximately 26,000 cubic yards.

No drilling or testing was conducted on the pervious material.

#### Rockfill and Riprap

Based on a reconnaissance of the local area, the best source of riprap and rockfill material appears to be a pinnacle named Dog Rock which

risers 90 feet above the surrounding serpentine 1 air mile to the west of the damsite. The pinnacle is composed of a hard, dense ultrabasic igneous rock and is favorably jointed for quarrying. Due to the steep walls of Dog Rock, a quarry face can be easily established. It is estimated that about 20 percent of the rock will be wasted. The haul distance by the Dry Creek Road is 1.4 miles, and the road has the added advantage of being downhill to the damsite. It is estimated that enough rock can be quarried to supply the 80,000 cubic yards needed for rockfill and riprap.

#### Concrete Material

Aggregate. The most suitable source of aggregate is the gravel plant previously noted at the confluence of Putah and Dry Creeks. This plant furnished material that passed the specifications of the State Division of Highways for the construction of a bridge. Sufficient reserves of the same material for the Dry Creek Project would be available. The aggregate is taken from Putah Creek because of the reactive ingredients found in the gravels along Dry Creek.

Cement. The nearest railroad is located in Calistoga. Cement would be hauled by truck about 17 miles from Calistoga to the job site.

#### Conclusions

1. The geologic investigation indicated that a properly constructed fill type dam up to 130 feet high can be built at the Collayomi damsite if due consideration is given to depth of weathered bedrock at both abutments.

2. Stripping depths should average 4 feet at each abutment and 3 feet in the channel section. For the cutoff trench an additional 27 feet of weathered bedrock should be excavated from the right abutment and 36 feet of weathered bedrock from the left abutment. Excavation for the cutoff trench in the channel section will vary from 4 feet of hard rock in the stream channel to 27 feet of weathered bedrock near the right abutment. This includes the excavation of an average thickness of 5 feet of terrace gravels which extend from near the stream channel to just above the Dry Creek Road. All excavation depths are measured normal to the surface.

3. The end-around spillway on the left abutment will be founded on rock on the inner edge of the cut and weathered material under the outer edge. This could result in differential settlement of the weir unless it is properly designed.

4. A grout curtain will be necessary. The grout take should be in the order of one-half to one sack per linear foot.

5. Abundant supplies of impervious material are readily available within 3,000 feet of the damsite. The nearest source of good pervious material is 3 air miles to the northeast along Putah Creek. Riprap and rockfill can be quarried at Dog Rock, 1 air mile to the west.

6. There should be no problem with leakage from the reservoir.

7. The silting rate is expected to be low.

8. A design seismic factor of 0.1g should be adequate for the proposed structure.

Recommendations

It is recommended that the following exploration be performed before final design of the dam is initiated:

1. Additional diamond drilling on both abutments and channel section to more accurately estimate rock characteristics and stripping depths. In addition, an adit should be driven into the right abutment.

2. Complete water testing of all drill holes to determine leakage and grout characteristics.

3. Drill and test blast quarry site.

4. Additional drilling and primary and secondary testing of the construction materials.

5. An ancient Indian culture has been identified in the general vicinity of Middletown. Prior to excavation of the impervious borrow areas, an examination should be made by a competent archeologist to determine if the area has an archeological value.



APPENDIX F

ECONOMIC ANALYSIS

OF THE

DRY CREEK PROJECT



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### Introduction

The Lake County Flood Control and Water Conservation District, in conjunction with the people from Collayomi and Long Valleys, have proposed the construction of a project to conserve and regulate the water of Dry Creek for beneficial use. The project would provide a dependable and adequate water supply for alleviating the present shortages and permit the economic expansion of the area. Until a water project is constructed, no significant increase in the development of the agricultural and urban potential is expected to take place in the foreseeable future.

The area of investigation encompasses about 16,400 acres of land. An estimated 5,700 gross acres are within the boundary of the proposed project service area which generally follows the 1,200-foot contour. This gross area was derived by eliminating those lands within the two valleys which, due to location, elevation, and soil conditions, were considered to be impractical to irrigate. It is anticipated that at full development, which is expected to occur by the fifteenth year after completion of project construction, approximately 3,500 acres of land will be irrigated with project water. The latter, or net project service area, was established by reducing the gross project service area by lands utilized for roads, canals, farmsteads, urban lands in Middletown, and 460 acres of land presently irrigated by direct stream diversion and ground water.

### Purpose and Scope

The objectives of this economic study were: (1) to estimate the irrigation and urban development within the proposed service area during

the 50-year study period, and the supply of water required to satisfy this development; and (2) to determine the economic justification and financial feasibility of the proposed project.

Economic evaluation procedures used for this study were those developed under the Watershed Protection and Flood Control Act (P. L. 83-566, as amended). This criteria was adopted in compliance with a resolution by local interests stating their intent to seek financial assistance under this act.

Benefits resulting from irrigation measures are mainly the difference in net income from production with and without the project. As there was no practical alternative source for urban water, benefits for urban water were measured on the basis of vendibility.

The cost of building, maintaining, and operating the project as well as all on-farm capital costs and farm production operation and maintenance costs required in connection with the irrigation facilities were considered.

Information obtained from published literature and from interviews with persons associated with the University of California at Davis, the Department of Water Resources, and local sources, was utilized in the investigation.

Data in the annual reports submitted by the Lake and Napa County Agricultural Commissioners, adjusted by information from the Lake County Farm Advisor and local residents, were used as the primary basis for the projection of yields and prices shown herein.

Information on the adaptability of crops to climate and soil conditions, adjusted by the economic criteria of market demand and potential

agricultural development in the local and regional areas, formed the basis for the projection of the crop patterns presented.

The economic analysis was based on a 50-year period divided into decades. The cost-price relationship for the base period (1952-56) was used to determine the payment capacities and benefits from the project. However, these data were adjusted by the U. S. Department of Agriculture long-term index  $\frac{1}{/}$  of 235 for prices received and 265 for prices paid to conform with the Soil Conservation Service method of analysis.

Urban water requirements were based upon the potential population growth of the area, including that growth attributable to availability of an adequate future water supply.

### Proposed Service Area

#### Physical Characteristics

The physical characteristics of the proposed service area pertaining to climate, topography, and soils, as they affect economic development, are discussed in the following paragraphs.

Climate. The proposed Dry Creek service area has a Mediterranean type climate, with moderate to high precipitation in the winter and little or no rainfall in the summer. The long-term average annual rainfall at Middletown, situated at the approximate center of the service area, is 46 inches. Annual rainfall at Lower Lake, about 25 miles north of Middletown, averages 29 inches, and at the Helen Mine, in the upper reaches of the Dry Creek Watershed about 5 miles from Middletown, 82 inches. There are no

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$\frac{1}{/}$  Base period 1910-14 = 100.

temperature records available for the Middletown area; however, by the use of data from nearby stations it is estimated that the average temperature for January is approximately 43°F, and for July about 72°F. Maximum and minimum temperatures are estimated to range from about 110°F in the summer to approximately 15°F in the winter. Snowfall, although occurring in the higher reaches of the watershed near the service area, is rare within the service area itself.

Topography. The general area is hilly and mountainous. Within the mountains are irregularly shaped narrow valleys, most of which occur along very irregular drainage lines. The proposed service area is located in Long and Collayomi Valleys, which are typical of the valleys found throughout the region. The service area lies at an elevation of about 1,200 feet, and is surrounded on the west by the Mayacmas Mountains rising to about 3,500 feet, on the north by Boggs Mountain rising to about 5,000 feet, and on the east and south by foothills typical of the Coast Range. The mountains surrounding the service area are covered by growths of natural grasses, manzanita, scrub oak, and various species of conifers.

Soils. The irrigable lands in the service area are of two distinct soil types: (1) recent alluvial soils with deep, permeable profiles, and (2) older terrace and upland soils with shallow soil profiles. Alluvial soils, which comprise about one-third of the land area, have medium to deep effective root zones, are permeable throughout, and free of salinity, alkalinity, rock, and other conditions limiting crop adaptability. The remaining two-thirds of the land has the same general qualities as those above but is restricted to crops with relatively shallow root systems.

### Development of the Area

The past and present development of the area served as a basis for the economic analysis of the project. Urban, suburban, agriculture, population, transportation, farm size, land values, and market aspects are discussed in the following paragraphs.

Urban. Although development of the present site of Middletown did not occur until 1871, a small village developed at Guenoc in Coyote Valley as early as 1860 functioning as a trading post and stagecoach stop. In the session of 1866-67, the State Legislature granted a toll road franchise beginning at Calistoga in Napa Valley and terminating at the present site of Middletown. In addition to its place as a travel stop, Middletown also gained some importance as a trading area for the cinnabar (quicksilver) mines located in the surrounding mountains. Middletown reached its zenith in 1895 when mining was at its peak.

At the present time, the majority of the urban development within the proposed service area has taken place in and around Middletown. Approximately 170 acres of land was classified as urban in 1960. Although future development is anticipated along the road bordering St. Helena Creek in Collayomi Valley, most of the future urban use will probably continue to occur at Middletown and its surrounding area.

Suburban. Some "residential farms" <sup>1/</sup> will be developed and require project water. Forecasts show that 450 acres of urban land use and 240 acres of residential farm land use can be expected within the proposed service area by the 50th year following project construction, assuming that such construction would take place prior to 1970.

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<sup>1/</sup> Avocational farms and agricultural enterprises which provide the resident an additional income supplemental to another source of livelihood.

Agriculture. Agriculture developed slowly in Collayomi Valley and Long Valley. No substantial buildup of agriculture was evident in the early years, although in the 1880's sheep were grazed in the valleys. At the present time about 800 <sup>1/</sup> acres of irrigated pasture and orchards and another 800 acres of dryland pasture and miscellaneous crops are being cultivated. Present land use in the project service area is summarized in Table 1.

Population. The population of Middletown in 1880 was about 350. This figure had increased to 500 by 1895. In 1960 the estimated population was 450. With additional water the increase in urban development is expected to accelerate. It is anticipated that the urban population in Middletown will be about 3,500 people by the year 2020.

Transportation. Another factor limiting the area's growth, in addition to the shortage of developed water, has been the relative lack of transportation facilities. Considerable study was made in the late 1800's of the potential for extending the railroad from Calistoga to Middletown and around the periphery of Clear Lake. Due to the lack of development in the area and indecision on the part of local people, the idea never took form. At the present time only three routes provide access to the Middletown area, and only one of these can be considered a medium-duty, all-purpose road.

Farm Sizes. Farms wholly or partially within the project service area range in size from less than 5 acres to 500 acres, with the following approximate distribution: less than 5 acres - 20 percent; 5 to 25 acres - 35 percent; 25-100 acres - 25 percent; 100-500 acres - 20 percent. There are approximately 125 farms located in Long and Collayomi Valleys.

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<sup>1/</sup> Of which 460 acres are located within the boundaries of the project service area.

Land Values. Land values within the agricultural area range from \$100 an acre for hilly brush land to \$1,000 an acre for the better orchard lands in Collayomi Valley.

Markets. Available information with respect to the agricultural commodities projected for the proposed service area indicate that the majority of the perennial crops will be marketed outside the two valleys. The wine grape production could readily be sold to the existing wineries in the Napa Valley to the south partially to offset the continuing loss of production in that area due to urban encroachment.<sup>1/</sup> Lake County pears have a nationwide reputation and existing outlets will be able to absorb the future increased production from the Middletown area. No difficulties should be encountered in marketing the yield from the projected 350 acres of walnuts. Most of the alfalfa, pasture and truck crops would be consumed locally.

### Evaluation of the Project

#### Sizing Factors

The project was sized to maximize net benefits based on the historical and computed flows in Dry Creek for the period 1906 through 1955. After the water supply, service area, crop pattern, and water requirements were determined, reservoir size was related to an array of tolerable agricultural deficiencies over the project life. In order to determine the optimum reservoir capacity, the probable dollar losses which would result from deficiencies of water yield in each dry year during the life of the project was estimated, and the costs of developing different

<sup>1/</sup> California Agriculture, December 1960 "Promising New Area for Premium Quality Wine Grapes to Replace Acreage Loss to Urbanization", A. J. Winkler, Professor of Viticulture, University of California, Davis.

reservoir capacities were determined. Active storage capacity was optimized at the point where any additional increase in active storage would cost more than it returned, or any decrease in active storage would reduce returns in an amount greater than the decreased storage costs. The optimum active storage capacity was found to be about 6,000 acre-feet.

Agricultural Development. The proposed service area is primarily dry-farmed at the present time. Transition to full irrigation will require a relatively long buildup period. Vineyards and tree crops have a natural buildup to full production of 7-12 years; hence, given the nature of the crop pattern it is unlikely that these crops will yield substantial benefits in the first decade of project life.

The crops projected in the proposed service area are types that would be adaptable to the region. The projected cropping pattern was based upon the physical factors of land class and climate, plus the economic factors of payment capacity for water, market potential, and the level of comparative advantage of the service area over other areas for specific crops.

In projecting the crop pattern, it was assumed that planting of the trees and vineyards will occur during the first few years of project operation. Consequently, full agricultural development is not expected to take place within the service area until the 15th year following completion of project construction. Table 2 shows the land use pattern anticipated during each decade of the 50-year repayment period.

Land suitable for the production of dry wine grapes in the Central Coastal area of California is limited. In recent years there has been a displacement of vineyards in this area due to the encroachment of urban facilities. As an example, grape acreages in Napa County declined from

12,400 acres in 1940 to 10,400 acres in 1960; Sonoma County declined from 22,000 acres in 1940 to 11,000 acres in 1960; and Mendocino County from 8,400 acres in 1940 to 5,400 acres in 1960. With the decline of grape acreage, a demand has been created in the area for lands that are suitable for the production of this type of crop.

At the present time there are about 40 acres of land within the service area planted to vineyards which demonstrates the suitability of growing wine grapes in the area. Due to the need for new grape acreage, the existing market for grapes in Napa Valley, suitable soil and climate conditions, and the high economic return which can be derived, the principal crop projected for the service area is dry wine type grapes. It is anticipated that approximately 60 percent of the agricultural service area at full development will be planted to vineyards.

One factor that could be a handicap and which has not been fully evaluated due to insufficient data is the possible hazard of spring frost. However, since the grape industry in Napa Valley and other areas has been affected by this condition in the past, it is believed this will not preclude the production of wine grapes in Collayomi and Long Valleys. Table 3 presents the projected service area crop pattern by land class at full development.

#### Irrigation Water Requirements

The irrigation water requirements for the proposed crops are shown below. An irrigation efficiency of 70 percent was used in the determination of these requirements. This efficiency can be attained by a combination of surface application methods and sprinkler systems.

Farm Delivery Irrigation Requirements

| <u>Crop</u>                           | <u>Annual water requirement in feet</u> |
|---------------------------------------|---|
| Wine Grapes                           | 1.4                                     |
| Deciduous Orchard - Pears             | 1.9                                     |
| Walnuts                               | 1.9                                     |
| Miscellaneous Field Crops - Dry Beans | 1.0                                     |
| Irrigated Pasture                     | 3.3                                     |
| Alfalfa                               | 2.9                                     |

Table 4 shows the projected water requirements for both agricultural and urban use during the five decades studied.

Urban Water Requirements

Municipal and residential farm domestic water requirements were estimated to range from 250 to 270 gallons per day per capita during the repayment period. This is equivalent to an annual per capita use of 0.28 to 0.30 acre-feet. These rates were derived by analyzing per capita water requirements in similar areas in which users are on metered systems. The projected municipal and residential farm population and the estimated urban water use is given below.

Projected Population Growth  
and Urban Water Use

| Project<br>year | <u>Population Projections</u>     |                              |              | <u>Water require-<br/>ment per<br/>capita (AF/Yr)</u> | <u>Total urban<br/>water require-<br/>ment (AF)</u> |
|-----------------|-----------------------------------|------------------------------|--------------|---|---|
|                 | <u>Municipal<br/>(Middletown)</u> | <u>Residential:<br/>farm</u> | <u>Total</u> |   |   |
| 5               | 510                               | 140                          | 650          | 0.277   | 180   |
| 15              | 610                               | 160                          | 770          | 0.286   | 220   |
| 25              | 825                               | 205                          | 1,030        | 0.291   | 300   |
| 35              | 1,350                             | 280                          | 1,630        | 0.294   | 480   |
| 45              | 2,700                             | 400                          | 3,100        | 0.300   | 930   |

### Crop Prices and Yields

The historical prices and yields reported by the Agricultural Commissioners of Lake and Napa Counties for the 5-year period 1952-56 inclusive, were the primary sources of data for the projected prices and yields used in the study. Information from other sources, including data from the California Crop and Livestock Reporting Service, was used where distortions in the county averages caused by dryland yields or lower yielding crops were evident.

Prices projected in this report represent the net amount received for a specific commodity at the delivery point. The projected yields are based on historical averages with slight adjustments made according to the types of land projected for a particular crop. In some cases, the projected yields are higher than the historical data because of these adjustments.

Historical and projected prices and yields for selected crops are shown in Tables 5 and 6, respectively.

### Production Costs

Production costs, both variable and fixed, were computed on the basis of unit costs prevailing for the 1952-56 period. A return to management of 10 percent of gross income was included in the costs. Variable costs include all operating costs during the production period and all charges to the point where the grower relinquished title of ownership of the crop. Fixed costs are those expenses that occur whether or not a crop is grown, such as interest and taxes on land, depreciation of buildings and equipment, and allowance for natural deterioration of the stand in the case of perennial plants. These costs were determined for each crop projected for the service area.

Payment Capacity

Payment capacity is the maximum amount the agricultural producer can afford to pay for project water at the farm headgate after deducting all the costs of production (including an imputed return for the farm operator's labor and management), except the cost of the water from the gross farm income. This residual is the amount a farmer could afford to pay for project water; however, it does not necessarily reflect his willingness to pay that amount for irrigation water.

Crop budgets were developed for those crops that were selected as being representative for the service area. Payment capacity derived from these budgets ranged from \$19.90 per acre for irrigated pasture to \$62.00 per acre for pears. The average payment capacity for the entire service area is approximately \$45.00 per acre. The payment capacities for those crops projected for the service area are shown in Table 7.

The payment capacity per acre-foot of water required for the various crops projected for the service area ranges from a low of \$6.00 per acre-foot for irrigated pasture to a high of \$40.40 per acre-foot for dry beans, with an average figure of \$26.30 per acre-foot. These figures were derived by applying the annual water requirements to the payment capacities shown in Table 7. A summary of the payment capacities per acre-foot of water required for the various crops at full development is shown in Table 8.

In view of the relatively low payment capacity for irrigated pasture and alfalfa in relation to the expected costs of water development, the acreage projected for these two types of crops was limited to soil improvement and crop rotation programs. Payment capacities for vineyard

and orchard crops indicate that these types could adequately pay the expected costs associated with surface water development.

Further analysis shows that for the project as a whole, the payment capacity as a percentage of gross income amounts to 13.1 percent, as a percentage of production costs it is 15.1 percent, and as a percentage of production costs excluding management costs it is 17.2 percent.

### Benefits

Benefits attributable to the Dry Creek Project were determined using criteria and procedures established under the Watershed Protection and Flood Prevention Act (P.L. 83-566, as amended). Three types of benefits, primary, secondary, and intangible, can be considered under this act.

Primary benefits from the project would be derived from two sources: (1) the sale of water for irrigation of agricultural lands, and (2) the sale of water for urban use. If the necessary facilities are provided, additional benefits would also accrue from recreation use in the reservoir area. Since it is not known whether recreation will be a project purpose, benefits derived from this source were not included.

Secondary benefits are estimated by the Soil Conservation Service, but are considered to accrue to the local economy rather than to the national economy as in the case of primary benefits. These include benefits resulting from the transportation, processing, and marketing of additional goods produced; and benefits from increased requirements for materials and services that will be incurred in connection with increased production.

Intangible benefits attributable to a project are not susceptible to monetary measurement and hence are not included in the computation of project benefits. These include such effects as improvement of water quality, reduction of fire insurance rates resulting from improved fire protection, and benefits attributable to reduction in health hazards.

Incomes and costs, as calculated for the 1952-56 base period, were adjusted by the U. S. Department of Agriculture indices for long-term projected prices received and prices paid to reflect the net income expected over the 50-year period of analysis. Data used for this adjustment factor are tabulated below.

Long term Adjustment Factors  
For Prices Received and Prices Paid

| Year                                   | : <u>USDA index figures</u> <u>1/</u> |                   |
|--|---------------------------------------|-------------------|
|  | : Prices paid                         | : Prices received |
| 1952                                   | 287                                   | 288               |
| 1953                                   | 279                                   | 258               |
| 1954                                   | 281                                   | 249               |
| 1955                                   | 281                                   | 236               |
| 1956                                   | 286                                   | 235               |
| Five year average                      | 282.8                                 | 253.2             |
| USDA long-term index                   | 265                                   | 235               |
| 1952-56 long-term<br>adjustment factor | 0.94                                  | 0.93              |

1/ U. S. Department of Agriculture, Sept. 1957,  
"Agricultural Price and Cost Projections",  
pages 8 and 9.

Agricultural Benefits

Agricultural benefits were derived by evaluating the difference in net income under project and nonproject conditions. The net income in each case was that amount remaining after growing, harvesting, and all other production costs exclusive of water, and land and management were deducted from the gross value of production.

Net Income - Nonproject Conditions. The principal crops in the service area under nonproject conditions are dry-land pasture and hay. In addition there are lesser amounts of small grains and walnuts, and minor amounts of dry-land wine grapes and deciduous orchards. It is assumed that without the project, this pattern would continue with little change during the five decades under investigation. Table 9 shows the projected crop pattern by decades under nonproject conditions.

Net income under nonproject conditions ranges from \$3.25 per acre for dry-land pasture to approximately \$72.00 per acre for dry-land deciduous orchards and is shown in Table 10. As indicated in Table 11, the average net income would be slightly more than \$7.75 per acre for the five decades. The average annual income from the proposed service area during the 50-year study period would amount to \$22,440 per year (adjusted for the long-term index factor of prices paid to prices received). The average annual adjusted income by decades is shown in Table 12.

Net Income - With Project. Local farmers, the county farm advisor, and others generally agree that given an adequate water supply, there would be a rapid development of wine grapes in the area. With project water, it is anticipated that the agricultural development will approximate that projected in Table 2. At the end of the initial 15-year buildup period, approximately 60 percent of the service area would be planted to wine grapes, 15 percent in pears, 10 percent in walnuts, and lesser acreages in irrigated pasture, truck crops, and alfalfa.

The value of irrigation water was based on approximately double the yields obtained under present dry-farmed conditions. It is estimated that it will require approximately a 15-year initial development period

to attain these yields and that on those lands having greater slopes, an additional on-farm capital investment of \$100 per acre for land improvement and sprinkler irrigation systems will be required.

The average annual production costs and net income by crops under project conditions is shown in Table 13. Income would range from a low of \$50.70 per acre for irrigated pasture to a high of \$167.00 per acre for irrigated pears. The average net income per acre by decades for the service area is indicated in Table 14. It should be noted that a lesser unit value per acre was used in the initial years of the project for wine grapes, deciduous orchards, and walnuts while these crops were being planted and brought into full production. Table 15 shows that the average annual equivalent income from the service area during the 50-year study period amounted to \$248,000 per year (adjusted for the long-term index factor of prices paid to prices received).

Irrigation Benefits. The irrigation benefits attributable to the project were considered to be the difference between the estimated net income under project and nonproject conditions. The average annual equivalent income under project conditions was estimated to be \$248,000, and \$22,440 for nonproject conditions. The difference of \$225,560 represents the increase in agricultural income that would be realized if the project were constructed.

#### Residential Farm Benefits

The benefits from this source are included with urban and agricultural benefits. The water used to irrigate the agricultural portion is expected to provide an average benefit to the landowner in the amount of the derived agricultural benefits for the same area. The portion utilized

as domestic water is projected at the same average benefit as the water provided for urban use.

### Urban Benefits

As there is no feasible alternative source of domestic water which could be developed at a reasonable cost, benefits from urban water were established on the basis of vendibility. The present cost of water to the user in the Middletown area is estimated to be \$60.00 per acre-foot. Considering associated costs required to distribute project water (distribution system, water treatment, storage tank, and other facilities) and associated benefits, vendibility of water to the Middletown water system is considered to be at least \$40.00 per acre-foot.

Based upon the projection of urban growth and the per capita unit water requirement, future water needs for domestic supplies were developed. The present worth of the benefits for the 50-year study period attributable to domestic water is \$342,490 with an average annual equivalent benefit of \$13,320. Projected income by decades from the sale of domestic water is shown in Table 16.

### Benefit-Cost Analysis

In establishing economic justification, a project is properly formulated if: (1) the estimated total economic benefits exceed the estimated economic costs; (2) each separable purpose provides benefits at least equal to its costs; (3) the scale of development is such as to provide maximum net benefits; and (4) there are no other economical means of accomplishing the same purpose.

Irrigation benefits were considered to be the difference in net adjusted income with and without the project less associated on-farm costs. The average annual equivalent agricultural income (benefits) with the project amounted to approximately \$248,000, and without the project to \$22,440. The average annual equivalent associated on-farm capital cost amounted to \$16,630, and is shown in Table 17. As these on-farm costs were used in the original crop budget analysis, and have already been included in the computation of agricultural income shown in Table 13, they were not deducted again in the benefit-cost analysis. Domestic (urban) benefits are estimated at an average annual equivalent of \$13,320 per year. The combined agricultural and domestic benefits total \$238,880. An annual operation and maintenance cost of the associated on-farm irrigation improvements, amounting to \$5,250, was subtracted from this figure giving a net average annual combined benefit for the project of \$233,630.

The estimated total capital cost of the project is \$3,359,700. Based on a 50-year project life and a 3 percent interest rate, the total average annual cost would be \$143,000. Of this amount, \$130,600 would be the average annual equivalent capital cost, and \$12,400 the average annual operation and maintenance cost.

Comparing the average annual net benefit of \$233,630 with the corresponding annual project cost of \$143,000 results in a benefit-cost ratio of 1.6:1 for the proposed Dry Creek Project. A summary of the benefits and costs is shown in Table 18.

Cost Allocation

Cost allocation is the process by which financial costs of a project are distributed equitably among project purposes. The method of allocating those costs is dependent upon the type of project and the criteria established by the organization which will finance the project.

As previously stated, the Dry Creek Project was analyzed on the assumption that it would be financed under the "Watershed Protection and Flood Prevention Act", Public Law 83-566, as amended. The allocation of project costs was made using the proportionate use of facilities method in accordance with criteria provided by the U. S. Soil Conservation Service, the agency responsible for the approval of projects seeking financing under Public Law 83-566.

The proportionate use of facilities method is based on the concept that the cost of jointly used facilities should be allocated among the various project purposes in proportion to the respective use of those facilities. Use of the reservoir was measured in terms of storage capacity. Use of the distribution system was based upon water delivery. In both instances the proportioned allocation of the capital and annual costs amounted to 94 percent for irrigation use and 6 percent for domestic use.

Under provisions of Public Law 83-566, the Federal Government may provide financial assistance to the local sponsors of a project by paying certain project costs. The project costs allocated to each purpose were, in turn, apportioned between the Federal Government and the local water users in accordance with the provisions of the Watershed Protection and Flood Prevention Act. The resulting capital and annual cost allocations for the project are shown in Table 19.

Financial Feasibility

Financial feasibility relates financial costs to project revenues. A project is financially feasible if: (1) the beneficiaries are ready, willing, and able to pay the reimbursable costs for project products and services within the repayment period; (2) sufficient capital is authorized and available to finance construction to completion; and (3) estimated revenue to be derived during the prescribed repayment period is sufficient to cover reimbursable project costs.

The total amount of the allocated cost to be repaid by the local interests was computed to be \$1,812,400. A repayment schedule has been developed to show the ability of the project beneficiaries, solely through the sale of developed water, to repay within 50 years the allocated cost plus interest at 3 percent, and a yearly operation and maintenance cost estimated at \$12,400.

Annual interest ranged from approximately \$54,370 during the initial year of the repayment period to about \$58,200 at the ninth year, and with a declining interest and loan balance, to \$1,330 at the 50th year. As net revenue (total income less operation and maintenance costs) showed a relatively uniform buildup from \$19,000 for the first year of the project to \$110,000 for the 50th year, that portion of the annual interest due, but not payable with current revenue, was recapitalized. Thus, the increase in balance due on the loan increased from the initial \$1,812,400 to approximately \$1,940,000 at the eighth year with a corresponding buildup in interest due during the initial years.

The payment capacity was determined to be \$26.30 per acre-foot for irrigation water, and \$40.00 per acre-foot for domestic water. The

allocated project costs, on an acre-foot basis, amounted to \$14.90 for irrigation water, and \$25.95 for domestic water. This indicates that the service area has the capability to repay the reimbursable portion of the cost.

If the price of urban water to Middletown was set at the payment capacity of \$40.00 per acre-foot, the price of agricultural water could be reduced to about \$14.25 per acre-foot. It is anticipated that the final charge for water to agriculture, however, will probably reflect a combination of assessment, taxation, and a fixed rate per acre-foot. A 50-year repayment schedule, based upon the price of agricultural water at \$14.25 per acre-foot and urban water at \$40.00 per acre-foot, is shown in Table 20.

#### Recreation

Construction of Collayomi Dam will create a small reservoir which will provide a limited opportunity for recreation use. Consideration should be given to the possibility of including recreation facilities in the project plan of development.

The benefits and costs involved will be dependent upon the type of recreation facilities included. The type to be included is a matter that should be decided by the local water agency responsible for the construction and operation of the project.

The major attraction and probably the major recreation use is anticipated to be fishing in the reservoir. Three schemes of reservoir fishery management were proposed for consideration by the Department of

Fish and Game. Scheme number two, "warmwater fishery plus early season trout fishery", was selected for the purpose of illustrating benefits and costs involved in a development of this type.

The cost of the recreation facilities was estimated to be \$550,000. The average annual equivalent cost would be \$21,380. In addition, an expenditure of \$10,000 annually would be needed to stock the reservoir with catchable size trout in order to provide satisfactory angling under this scheme.

The average annual recreation benefit projected under scheme number two was estimated at \$26,960. Table 21 gives the recreation benefits by decades for this scheme.

#### Summary

The proposed Dry Creek service area is located in Long and Collayomi Valleys of Lake County at an elevation of 1,100 to 1,200 feet. It comprises a net area of 5,680 acres of which 3,500 acres are projected to be irrigated with project water. The area has a Mediterranean type climate, with moderate to high precipitation in the winter, and little or no rainfall in the summer. Middletown is the only urban community within the area. The 1960 population was about 450; by 2020 the total population is expected to increase to 3,500.

Irrigated crops and water requirements projected for the service area are as follows:

| <u>Crop</u>               | <u>Acres</u> | <u>Percent total</u> | <u>Annual water<br/>requirement<br/>in feet</u> |
|---------------------------|--------------|----------------------|---|
| Wine Grapes               | 2,000        | 57.1                 | 1.4   |
| Deciduous Orchard         | 500          | 14.3                 | 1.9   |
| Walnuts                   | 350          | 10.0                 | 1.9   |
| Miscellaneous Field Crops | 275          | 7.9                  | 1.0   |
| Irrigated Pasture         | 275          | 7.9                  | 3.3   |
| Alfalfa                   | <u>100</u>   | <u>2.8</u>           | <u>2.9</u>                                      |
| TOTAL                     | 3,500        | 100.0                | 1.7   |

Total water use ranged from an average annual first decade requirement of 180 acre-feet for domestic use and 3,530 acre-feet for agricultural use, to the fifth decade requirement of 930 acre-feet for domestic use and 5,470 acre-feet for agricultural use.

Payment capacity for project water amounted to \$40.00 per acre-foot for domestic water and \$26.30 per acre-foot for irrigation water.

Project benefits, which were considered to be the net adjusted income, were calculated by deducting the income from the service area without the project from the income with the project. The average annual net income that would be gained amounted to \$233,630. With an estimated annual cost of \$143,000, the benefit-cost ratio for the Dry Creek Project would be 1.6:1.

The capital cost of the project amounted to \$3,359,700, of which \$1,547,300 could be requested under a Public Law 83-566 grant, leaving a balance of \$1,812,400 as reimbursable under a 50-year 3 percent U. S. Farmers Home Administration loan. The revenue obtained by the pricing of water at \$40.00 per acre-foot for domestic use and \$14.25 per acre-foot for

agricultural use would be sufficient to pay the reimbursable portion of the project within the 50-year repayment period and still provide a reasonable income for the farm operator. Construction of the project will provide a small reservoir with a limited opportunity for recreation development. Analysis was made of one of the three schemes of development suggested by the Department of Fish and Game. Consideration should be given to the possibility of including recreation facilities as part of the project.

A summary of the economic and financial features of the project at full development is shown in Table 22.

TABLE 1  
Present Land Use Pattern<sup>1/</sup>  
(in acres)

| Land use                    | : Service area | : Excluded lands : presently irrigated | : Gross project : service area |
|-----------------------------|----------------|--|--------------------------------|
| Irrigated Lands             |                |  |                                |
| Pasture                     | 330            | 330                                    | 0                              |
| Sudan Grass                 | 80             | 80                                     | 0                              |
| Walnuts                     | 50             | 50                                     | 0                              |
| TOTAL                       | <u>460</u>     | <u>460</u>                             | <u>0</u>                       |
| Dry-Farmed Lands            |                |  |                                |
| Grain and Hay               | 590            | 0                                      | 590                            |
| Prunes                      | 30             | 0                                      | 30                             |
| Apples                      | 10             | 0                                      | 10                             |
| Walnuts                     | 90             | 0                                      | 90                             |
| Miscellaneous Orchard       | 10             | 0                                      | 10                             |
| Vineyard                    | 40             | 0                                      | 40                             |
| TOTAL                       | <u>770</u>     | <u>0</u>                               | <u>770</u>                     |
| Other Land                  |                |  |                                |
| Present Urban <sup>2/</sup> | 170            | 0                                      | 170                            |
| Dry Land Pasture            | 4,280          | 0                                      | 4,280                          |
| TOTAL                       | <u>4,450</u>   | <u>0</u>                               | <u>4,450</u>                   |
| GRAND TOTAL                 | 5,680          | 460                                    | 5,220                          |

<sup>1/</sup> Based on 1960 data.  
<sup>2/</sup> Includes approximately 45 acres classified as residential farms.

TABLE 2  
Projected Land Use Pattern  
Under Project Conditions 1/  
(in acres)

| Crop   | Decades      |              |              |              |              | Five-decade<br>average |
|--|--------------|--------------|--------------|--------------|--------------|------------------------|
|  | 1            | 2            | 3            | 4            | 5            |                        |
| Irrigated                                      |              |              |              |              |              |                        |
| Wine Grapes                                    | 1,380        | 2,000        | 2,000        | 1,995        | 1,985        | 1,870                  |
| Deciduous Orchard                              | 260          | 500          | 500          | 490          | 475          | 445                    |
| Walnuts  | 200          | 350          | 350          | 340          | 325          | 315                    |
| Misc. Field                                    | 130          | 275          | 275          | 255          | 215          | 230                    |
| Pasture  | 130          | 275          | 275          | 255          | 215          | 230                    |
| Alfalfa  | <u>55</u>    | <u>100</u>   | <u>100</u>   | <u>95</u>    | <u>85</u>    | <u>85</u>              |
| TOTAL  | 2,155        | 3,500        | 3,500        | 3,430        | 3,300        | 3,175                  |
| Urban  | 125          | 135          | 155          | 230          | 360          | 200                    |
| Residential Farms <sup>2/</sup><br>(irrigated) | (55)         | (65)         | (85)         | (155)        | (250)        | (120)                  |
| Total Nonwater Service Area                    | <u>2,940</u> | <u>1,535</u> | <u>1,565</u> | <u>1,560</u> | <u>1,560</u> | <u>1,845</u>           |
| GROSS AREA <sup>3/</sup>                       | 5,220        | 5,220        | 5,220        | 5,220        | 5,220        | 5,220                  |

1/ Decadal average.

2/ Included in irrigated agricultural acreage above.

3/ Excludes 460 acres of land presently being irrigated.

TABLE 3

Projected Crop Pattern by  
Land Class at Full Development  
(in acres)

| Land class  | : Acres             | : Deciduous:  | : Walnuts     | : Wine grapes: | : Misc.:      | : Pasture     | : Alfalfa     |
|-------------|---------------------|---------------|---------------|----------------|---------------|---------------|---------------|
| V           | 1,220               | 400           | 290           | 340            | 90            |               | 100           |
| Vp          | 1,310               |               |               | 950            | 185           | 175           |               |
| H           | 160                 | 100           | 60            |                |               |               |               |
| Hp          | 700                 |               |               | 600            |               | 100           |               |
| M           | 40                  |               |               | 40             |               |               |               |
| Mp          | <u>70</u>           | <u>      </u> | <u>      </u> | <u>70</u>      | <u>      </u> | <u>      </u> | <u>      </u> |
| Subtotal    | 3,500 <sup>1/</sup> | 500           | 350           | 2,000          | 275           | 275           | 100           |
| Urban       | 135                 |               |               |                |               |               |               |
| Other Lands | 1,585               |               |               |                |               |               |               |
| GRAND TOTAL | 5,220               |               |               |                |               |               |               |

<sup>1/</sup> Net irrigated acreage.

TABLE 4  
Projected Water Requirements<sup>1/</sup>  
(in acre-feet)

| Class                                      | Decade     |            |            |            |            |
|--|------------|------------|------------|------------|------------|
|  | 1          | 2          | 3          | 4          | 5          |
| Wine Grapes                                | 1,930      | 2,800      | 2,800      | 2,800      | 2,780      |
| Deciduous Orchard                          | 500        | 950        | 950        | 940        | 900        |
| Walnuts                                    | 380        | 670        | 670        | 650        | 620        |
| Miscellaneous Field                        | 130        | 270        | 270        | 260        | 220        |
| Pasture                                    | 430        | 910        | 910        | 840        | 710        |
| Alfalfa                                    | <u>160</u> | <u>290</u> | <u>290</u> | <u>280</u> | <u>240</u> |
| Total Agriculture                          | 3,530      | 5,890      | 5,890      | 5,770      | 5,470      |
| Urban                                      | 140        | 170        | 240        | 390        | 810        |
| Residential Farm (irrigated) <sup>2/</sup> | ---        | ---        | ---        | ---        | ---        |
| Residential Farm (domestic)                | <u>40</u>  | <u>50</u>  | <u>60</u>  | <u>90</u>  | <u>120</u> |
| TOTAL WATER USE                            | 3,710      | 6,110      | 6,190      | 6,250      | 6,400      |

<sup>1/</sup> Decadal average.

<sup>2/</sup> Included in irrigated agricultural requirements above.

TABLE 5

Historical and Projected Prices  
Received for Selected Crops <sup>1/</sup>  
(per unit)

| Crop                      | Unit | Historical prices |           |           |           |           | Statewide           |  |          |
|---------------------------|------|-------------------|-----------|-----------|-----------|-----------|---------------------|--|----------|
|                           |      |                   |           |           |           |           | crop                |  |          |
|                           |      | 1952 (\$)         | 1953 (\$) | 1954 (\$) | 1955 (\$) | 1956 (\$) | 5-year average (\$) | reporting service 1952-56 av. price (\$) |          |
| Wine Grapes               | Ton  | 49.50             | 52.20     | 52.50     | 60.90     | 60.00     | 55.00               | 38.50                                    | 50.00    |
| Deciduous Orchard (Pears) | Ton  | 64.00             | 86.00     | 80.00     | 89.00     | 80.00     | 79.80               | 70.30                                    | 75.00    |
| Walnuts                   | Ton  | 578.00            | 420.00    | 440.00    | 600.00    | 547.00    | 517.00              | 434.40                                   | 450.00   |
| Misc. Field Dry Beans     | Ton  | 202.00            | 194.00    | 178.00    | 164.00    | 160.00    | 179.60              | 179.60                                   | 180.00   |
| Beef Cattle               |      |                   |           |           |           |           |                     | 19.20 2/                                 | 20.00 2/ |
| Alfalfa                   | Ton  |                   | 22.00     | 21.00     | 28.00     | 27.00     | 24.50 3/            | 25.00                                    | 25.00    |
| Barley                    | Ton  |                   | 58.00     | 50.00     | 45.00     | 52.00     | 51.25 3/            | 51.20                                    | 45.00    |

<sup>1/</sup> Lake County averages other than Napa County for wine grapes and California statewide average for dry beans.

<sup>2/</sup> Per CWT stocker and feeder.

<sup>3/</sup> 4-year average.

TABLE 6  
Historical and Projected Yields  
For Selected Irrigated Crops  
(per acre) <sup>1/</sup>

| Crop                         | Unit | Historical yields |      |      |      |      | 5-year<br>average | 1956 | Statewide<br>crop<br>reporting<br>service<br>1952-56 av. | Projected<br>yield <u>2/</u> |
|------------------------------|------|-------------------|------|------|------|------|-------------------|------|--|------------------------------|
|                              |      | 1952              | 1953 | 1954 | 1955 | 1956 |                   |      |  |                              |
| Wine Grapes                  | Tons | 2.40              | 2.81 | 3.32 | 3.14 | 3.97 | 3.13              | 4.2  | 6.0  |                              |
| Deciduous Orchard<br>(Pears) | Tons | 11.7              | 7.8  | 13.2 | 6.1  | 13.2 | 10.4              | 9.4  | 10.0   |                              |
| Walnuts                      | Tons | .59               | .40  | .62  | .55  | .49  | .53               | .58  | .8   |                              |
| Misc. Field<br>Dry Beans     | Tons | .66               | .70  | .725 | .64  | .73  | .69               | .69  | .8   |                              |
| Pasture                      | AUM  |                   |      |      |      |      |                   |      | 12.0 <u>3/</u>   |                              |
| Alfalfa                      | Tons |                   | 4.5  | 4.5  | 3.0  | 3.0  | 3.75 <u>4/</u>    | 4.64 | 5.2  |                              |
| Barley                       | Tons |                   | .67  | .67  | .78  | .75  | .72 <u>4/</u>     | .91  | 1.0  |                              |

<sup>1/</sup> Lake County averages other than Napa County for wine grapes and California statewide average for dry beans.

<sup>2/</sup> Projected for irrigated conditions.

<sup>3/</sup> 1 AUM (animal unit month) = 45 lbs. of grain.

<sup>4/</sup> 4-year average.

TABLE 7  
Estimated Payment Capacity  
(per acre)

| Crop                            | Gross<br>income<br>\$ | Costs          |             |                            |  | Total<br>cost<br>\$ | Payment<br>capacity<br>\$ |
|---------------------------------|-----------------------|----------------|-------------|----------------------------|--|---------------------|---------------------------|
|                                 |                       | Variable<br>\$ | Fixed<br>\$ | Management<br>charge<br>\$ |  |                     |                           |
| Wine Grapes                     | 300.00                | 129.85         | 96.95       | 30.00                      |  | 256.80              | 43.20                     |
| Deciduous<br>Orchard -<br>Pears | 750.00                | 461.45         | 151.55      | 75.00                      |  | 688.00              | 62.00                     |
| Walnuts                         | 360.00                | 133.05         | 132.65      | 36.00                      |  | 301.70              | 58.30                     |
| Misc. Field<br>Dry Beans        | 150.00                | 43.75          | 50.85       | 15.00                      |  | 109.60              | 40.40                     |
| Pasture -<br>Beef Cattle        | 108.00                | 31.10          | 46.20       | 10.80                      |  | 88.10               | 19.90                     |
| Alfalfa                         | 130.00                | 43.85          | 52.30       | 13.00                      |  | 109.15              | 20.85                     |

TABLE 8  
Summary of Annual Payment Capacities  
at Full Development

| Crop         | Acres | Gross income | Production costs | Management charge | Total costs  | Payment capacity | Annual irrigation requirement     | Payment capacity per acre-foot |
|--------------|-------|--------------|------------------|-------------------|--------------|------------------|-----------------------------------|--------------------------------|
|              |       | \$           | \$               | \$                | \$           | \$               | acre-foot                         | \$                             |
| Wine Grapes  | 2,000 | 300.00       | 226.80           | 30.00             | 256.80       | 43.20            | 1.4 <sup>2</sup> / <sub>3</sub>   | 30.85                          |
| Total        |       | 600,000.00   | 453,600.00       | 60,000.00         | 513,600.00   | 86,400.00        | 2,800 <sup>2</sup> / <sub>3</sub> |                                |
| Dec. Orchard | 500   | 750.00       | 613.00           | 75.00             | 688.00       | 62.00            | 1.9                               | 32.65                          |
| Total        |       | 375,000.00   | 306,500.00       | 37,500.00         | 344,000.00   | 31,000.00        | 950                               |                                |
| Walnuts      | 350   | 360.00       | 265.70           | 36.00             | 301.70       | 58.30            | 1.9                               | 30.70                          |
| Total        |       | 126,000.00   | 92,995.00        | 12,600.00         | 105,595.00   | 20,405.00        | 670                               |                                |
| Misc. Field  | 275   | 150.00       | 94.60            | 15.00             | 109.60       | 40.40            | 1.0                               | 40.40                          |
| Total        |       | 41,250.00    | 26,015.00        | 4,125.00          | 30,140.00    | 11,110.00        | 270                               |                                |
| Pasture      | 275   | 108.00       | 77.30            | 10.80             | 88.10        | 19.90            | 3.3                               | 6.00                           |
| Total        |       | 29,700.00    | 21,258.00        | 2,970.00          | 24,228.00    | 5,472.00         | 910                               |                                |
| Alfalfa      | 100   | 130.00       | 96.15            | 13.00             | 109.15       | 20.85            | 2.9                               | 7.20                           |
| Total        |       | 13,000.00    | 9,615.00         | 1,300.00          | 10,915.00    | 2,085.00         | 290                               |                                |
| TOTAL        | 3,500 | 1,184,950.00 | 909,983.00       | 118,495.00        | 1,028,478.00 | 156,472.00       | 5,890                             |                                |
| Average      |       | 338.55       | 260.00           | 33.85             | 293.85       | 44.70            | 1.7                               | 26.30                          |

1/ Including the irrigated area in residential farms.

2/ In feet.

3/ In acre-feet.

TABLE 9  
Projected Crop Pattern Under Nonproject Conditions  
(in acres)

| Crop              | Decade       |              |              |              |              | Five-decade<br>average |
|-------------------|--------------|--------------|--------------|--------------|--------------|------------------------|
|                   | 1            | 2            | 3            | 4            | 5            |                        |
| Nonirrigated:     |              |              |              |              |              |                        |
| Wine Grapes       | 50           | 50           | 50           | 50           | 50           | 50                     |
| Deciduous Orchard | 50           | 50           | 50           | 50           | 50           | 50                     |
| Walnuts           | 100          | 100          | 100          | 100          | 100          | 100                    |
| Small Grain       | 300          | 600          | 600          | 600          | 600          | 540                    |
| Pasture           | <u>1,655</u> | <u>2,700</u> | <u>2,700</u> | <u>2,700</u> | <u>2,700</u> | <u>2,490</u>           |
| TOTAL             | 2,155        | 3,500        | 3,500        | 3,500        | 3,500        | 3,230                  |

TABLE 10  
Average Annual Production Costs  
and Net Income Under Nonproject Conditions

| Crop              | Production cost per acre |                    |                                     |                                    | Gross farm                     |                                    |
|-------------------|--------------------------|--------------------|-------------------------------------|------------------------------------|--------------------------------|------------------------------------|
|                   | Variable :<br>(\$)       | Cash :<br>(\$)     | Interest and depreciation :<br>(\$) | Total cost <sup>1/</sup> :<br>(\$) | income :<br>per acre :<br>(\$) | Net income :<br>per acre :<br>(\$) |
| Wine Grapes       | 61.55                    | 10.60              | 35.30                               | 107.45                             | 150.00                         | 42.55                              |
| Deciduous Orchard | 303.00                   | 25.85              | 49.10                               | 377.95                             | 450.00                         | 72.05                              |
| Walnuts           | 87.30                    | 13.35              | 48.50                               | 149.15                             | 180.00                         | 30.85                              |
| Small Grain       | 18.00                    | 3.80               | 7.20                                | 29.00                              | 45.00                          | 16.00                              |
| Pasture           | ---                      | 1.75 <sup>2/</sup> | ---                                 | 1.75                               | 5.00 <sup>3/</sup>             | 3.25                               |

1/ Not including interest on land or imputed management charges.  
2/ Land tax.  
3/ Rental value for pasture.

TABLE 11

Average Net Income Per Acre  
Under Nonproject Conditions  
(by decades)

| Crop              | : Net :<br>: income :<br>: per :<br>: acre : | 1st decade                        |           |           | 2nd decade                        |           |           | 3rd decade                        |           |           | 4th decade                        |           |           | 5th decade                        |           |           |
|-------------------|--|-----------------------------------|-----------|-----------|-----------------------------------|-----------|-----------|-----------------------------------|-----------|-----------|-----------------------------------|-----------|-----------|-----------------------------------|-----------|-----------|
|                   |  | : Total :<br>: income :<br>: (\$) |           |           | : Total :<br>: income :<br>: (\$) |           |           | : Total :<br>: income :<br>: (\$) |           |           | : Total :<br>: income :<br>: (\$) |           |           | : Total :<br>: income :<br>: (\$) |           |           |
|                   |  | : Acres :                         | : Acres : | : Acres : | : Acres :                         | : Acres : | : Acres : | : Acres :                         | : Acres : | : Acres : | : Acres :                         | : Acres : | : Acres : | : Acres :                         | : Acres : | : Acres : |
| Wine Grapes       | 42.55  | 500                               | 21,280    | 500       | 21,280                            | 500       | 21,280    | 500                               | 21,280    | 500       | 21,280                            | 500       | 21,280    | 500                               | 21,280    | 500       |
| Deciduous Orchard | 72.05  | 500                               | 36,020    | 500       | 36,020                            | 500       | 36,020    | 500                               | 36,020    | 500       | 36,020                            | 500       | 36,020    | 500                               | 36,020    | 500       |
| Walnuts           | 30.85  | 1,000                             | 30,850    | 1,000     | 30,850                            | 1,000     | 30,850    | 1,000                             | 30,850    | 1,000     | 30,850                            | 1,000     | 30,850    | 1,000                             | 30,850    | 1,000     |
| Grain             | 16.00  | 3,000                             | 48,000    | 6,000     | 96,000                            | 6,000     | 96,000    | 6,000                             | 96,000    | 6,000     | 96,000                            | 6,000     | 96,000    | 6,000                             | 96,000    | 6,000     |
| Pasture           | 3.25   | 16,550                            | 53,790    | 27,000    | 87,750                            | 27,000    | 87,750    | 27,000                            | 87,750    | 27,000    | 87,750                            | 27,000    | 87,750    | 27,000                            | 87,750    | 27,000    |
| Total             | -----  | 21,550                            | 189,940   | 35,000    | 271,900                           | 35,000    | 271,900   | 35,000                            | 271,900   | 35,000    | 271,900                           | 35,000    | 271,900   | 35,000                            | 271,900   | 35,000    |
| Average per acre  | -----  | 8.80                              |           |           | 7.75                              |           |           | 7.75                              |           |           | 7.75                              |           |           | 7.75                              |           |           |

TABLE 12

Average Annual Equivalent Income  
Under Nonproject Conditions

| Decade                                  | Total<br>productive<br>acreage | Average<br>net income<br>per acre<br>(\$) | Total net<br>income <sup>1/</sup><br>(\$) | Present worth<br>factor at<br>3 percent | Present worth<br>of income<br>(\$) | Present worth<br>of income <sup>2/</sup><br>(\$) |
|---|--------------------------------|---|---|---|------------------------------------|--|
| 1                                       | 21,550                         | 8.80                                      | 189,940                                   | .8626                                   | 163,840                            | 147,990  |
| 2                                       | 35,000                         | 7.75                                      | 271,900                                   | .6419                                   | 174,535                            | 158,380  |
| 3                                       | 35,000                         | 7.75                                      | 271,900                                   | .4776                                   | 129,860                            | 117,840  |
| 4                                       | 35,000                         | 7.75                                      | 271,900                                   | .3554                                   | 96,630                             | 87,690   |
| 5                                       | 35,000                         | 7.75                                      | 271,900                                   | .2644                                   | 71,890                             | 65,240   |
| TOTAL                                   | 161,550                        | 7.90                                      | 1,277,540                                 | -----                                   | 636,755                            | 577,140  |
| Average Annual Equivalent <sup>3/</sup> |                                |   |   |   | 24,750                             | 22,440   |

<sup>1/</sup> Interest on land and imputed management charge have not been deducted.

<sup>2/</sup> Adjusted to the long-term prices received and prices paid.

<sup>3/</sup> Capital recovery factor of 50 years at 3 percent = .03887.

TABLE 13  
Average Annual Production Costs and Net Income  
Under Project Conditions

| Crop                | Production cost per acre |       |              |                    | Gross farm |          | Net income    |
|---------------------|--------------------------|-------|--------------|--------------------|------------|----------|---------------|
|                     | Variable                 | Cash  | Interest and | Total              | income     | per acre |               |
|                     | (\$)                     | (\$)  | depreciation | cost <sup>1/</sup> | (\$)       | (\$)     | per acre (\$) |
| Wine Grapes         | 129.85                   | 22.50 | 49.45        | 201.80             | 300.00     |          | 98.20         |
| Deciduous Orchard   | 461.45                   | 50.05 | 71.50        | 583.00             | 750.00     |          | 167.00        |
| Walnuts             | 133.05                   | 32.55 | 75.10        | 240.70             | 360.00     |          | 119.30        |
| Miscellaneous Field | 33.70                    | 10.65 | 25.25        | 69.60              | 150.00     |          | 80.40         |
| Pasture             | 31.10                    | 8.25  | 17.95        | 57.30              | 108.00     |          | 50.70         |
| Alfalfa             | 43.85                    | 9.55  | 22.75        | 76.15              | 130.00     |          | 53.85         |

<sup>1/</sup> Not including interest on land, imputed management charge, or water cost.

TABLE 14

Average Net Income Per Acre  
Under Project Conditions  
(by decades)

| Crop              | Net<br>: income<br>: per<br>: acre | 1st decade     |           |        | 2nd decade     |        |           | 3rd decade     |           |        | 4th decade     |  |  | 5th decade     |  |  |
|-------------------|------------------------------------|----------------|-----------|--------|----------------|--------|-----------|----------------|-----------|--------|----------------|--|--|----------------|--|--|
|                   |                                    | : Total        |           |        | : Total        |        |           | : Total        |           |        | : Total        |  |  | : Total        |  |  |
|                   |                                    | : income       |           |        | : income       |        |           | : income       |           |        | : income       |  |  | : income       |  |  |
|                   |                                    | : Acres : (\$) |           |        | : Acres : (\$) |        |           | : Acres : (\$) |           |        | : Acres : (\$) |  |  | : Acres : (\$) |  |  |
| Wine Grapes       | 1/                                 | 13,800         | 721,575   | 20,000 | 1,889,560      | 20,000 | 1,964,000 | 19,940         | 1,958,110 | 19,840 | 1,948,290      |  |  |                |  |  |
| Deciduous Orchard | 1/                                 | 2,600          | 133,765   | 5,000  | 726,285        | 5,000  | 835,000   | 4,920          | 821,640   | 4,760  | 794,920        |  |  |                |  |  |
| Walnuts           | 1/                                 | 2,000          | 52,730    | 3,500  | 326,645        | 3,500  | 417,550   | 3,420          | 408,005   | 3,260  | 388,920        |  |  |                |  |  |
| Misc. Field       | 80.40                              | 1,315          | 105,725   | 2,750  | 221,100        | 2,750  | 221,100   | 2,540          | 204,215   | 2,150  | 172,860        |  |  |                |  |  |
| Pasture           | 50.70                              | 1,315          | 66,670    | 2,750  | 139,425        | 2,750  | 139,425   | 2,540          | 128,775   | 2,150  | 109,005        |  |  |                |  |  |
| Alfalfa           | 53.85                              | 550            | 29,620    | 1,000  | 53,850         | 1,000  | 53,850    | 940            | 50,620    | 840    | 45,230         |  |  |                |  |  |
| Total             | ---                                | 21,580         | 1,110,085 | 35,000 | 3,356,865      | 35,000 | 3,630,925 | 34,300         | 3,571,365 | 33,000 | 3,459,225      |  |  |                |  |  |
| Average per acre  | ---                                | 51.45          | 95.90     |        | 103.75         |        |           | 104.10         |           |        | 104.85         |  |  |                |  |  |

1/ Reflects reduced income during period of perennial build-up:

|                   |         |          |          |          |
|-------------------|---------|----------|----------|----------|
| Wine Grapes       | \$52.30 | \$ 94.50 | \$ 98.20 | \$ 98.20 |
| Deciduous Orchard | 51.45   | 145.25   | 167.00   | 167.00   |
| Walnuts           | 26.35   | 93.35    | 119.30   | 119.30   |

TABLE 15

Average Annual Equivalent Income  
Under Project Conditions

| Decade                                  | Total<br>productive<br>acreage | Average<br>net income<br>per acre<br>(\$) | Total net<br>income <sup>1/</sup><br>(\$) | Present worth<br>factor at 3<br>percent | Present worth<br>of income<br>(\$) | Present worth<br>of income <sup>2/</sup><br>(\$) |
|---|--------------------------------|---|---|---|------------------------------------|--|
| 1                                       | 21,580                         | 51.45                                     | 1,110,085                                 | .8626                                   | 957,560                            | 871,000  |
| 2                                       | 35,000                         | 95.90                                     | 3,356,865                                 | .6419                                   | 2,154,775                          | 1,955,815  |
| 3                                       | 35,000                         | 103.75                                    | 3,630,925                                 | .4776                                   | 1,734,130                          | 1,573,490  |
| 4                                       | 34,300                         | 104.10                                    | 3,571,365                                 | .3554                                   | 1,269,265                          | 1,151,595  |
| 5                                       | <u>33,000</u>                  | <u>104.85</u>                             | <u>3,459,225</u>                          | .2644                                   | <u>914,620</u>                     | <u>828,480</u>                                   |
| TOTAL                                   | 158,880                        | 95.20                                     | 15,128,465                                | -----                                   | 7,030,350                          | 6,380,380  |
| Average Annual Equivalent <sup>3/</sup> |                                |   |   |   | 273,270                            | 248,000  |

<sup>1/</sup> Water costs, interest on land, and imputed management charge have not been deducted.

<sup>2/</sup> Adjusted to the long-term prices received and prices paid.

<sup>3/</sup> Capital recovery factor of 50 years at 3 percent = .03887.

TABLE 16  
Net Income from Domestic Water Sales  
(by decades)

| Decade :                                | Total domestic water use (acre-feet) : | Price per acre-foot (\$) | Total net income (\$) | Present worth factor at 3 percent : | Present worth of income (\$) |
|---|--|--------------------------|-----------------------|-------------------------------------|------------------------------|
| 1                                       | 1,800                                  | 40.00                    | 72,000                | .8626                               | 62,105                       |
| 2                                       | 2,200                                  | 40.00                    | 88,000                | .6419                               | 56,485                       |
| 3                                       | 3,000                                  | 40.00                    | 120,000               | .4776                               | 57,310                       |
| 4                                       | 4,800                                  | 40.00                    | 192,000               | .3554                               | 68,235                       |
| 5                                       | <u>9,300</u>                           | <u>40.00</u>             | <u>372,000</u>        | .2644                               | <u>98,355</u>                |
| TOTAL                                   | 21,100                                 | 40.00                    | 844,000               |                                     | 342,490                      |
| Average Annual Equivalent <sup>1/</sup> |  |                          |                       |                                     | 13,320                       |

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<sup>1/</sup> Capital recovery factor of 50 years at 3 percent = .03887.

TABLE 17

Amortization of Associated  
On-Farm Capital Costs

| Item              | :<br>: Economic<br>: life :<br>: (years) | : Interest :<br>: rate :<br>: (%) | : Amorti-<br>: zation :<br>: factor : | : Total :<br>: cost :<br>: (\$) | : Average annual<br>: equivalent cost<br>: (\$) |
|-------------------|--|-----------------------------------|---------------------------------------|---------------------------------|---|
| Land Leveling     | 20                                       | 6                                 | .08718                                | 89,250                          | 7,780   |
| Irrigation System | 20                                       | 6                                 | .08718                                | 42,000                          | 3,660   |
| Farm Drainage     | 20                                       | 6                                 | .08718                                | 24,500                          | 2,140   |
| Fencing           | 20                                       | 6                                 | .08718                                | <u>35,000</u>                   | <u>3,050</u>                                    |
| TOTAL             |  |                                   |                                       | 190,750                         | 16,630  |

TABLE 18

## Summary of Benefits and Costs

## A. Benefits

## Net Income with Project

|             |               |           |
|-------------|---------------|-----------|
| Agriculture | \$248,000     |           |
| Domestic    | <u>13,320</u> |           |
| Total       |               | \$261,320 |

|                               |                  |  |
|-------------------------------|------------------|--|
| Net Income Without Project    | 22,440           |  |
| Net Annual Increase in Income | <u>\$238,880</u> |  |

## Annual Associated Costs

|                                       |              |              |
|---------------------------------------|--------------|--------------|
| Amortized Capital Costs <sup>1/</sup> | (16,630)     |              |
| Operation and Maintenance             | <u>5,250</u> |              |
| Total                                 |              | <u>5,250</u> |

|                            |                  |  |
|----------------------------|------------------|--|
| Net Annual Project Benefit | <u>\$233,630</u> |  |
|----------------------------|------------------|--|

## B. Costs

## Average Annual Project

|                     |               |         |
|---------------------|---------------|---------|
| Dam and Reservoir   | 96,100        |         |
| Distribution System | <u>34,500</u> |         |
| Total               |               | 130,600 |

## Operation and Maintenance

|                     |               |               |
|---------------------|---------------|---------------|
| Dam and Reservoir   | 2,200         |               |
| Distribution System | <u>10,200</u> |               |
| Total               |               | <u>12,400</u> |

|                    |                  |  |
|--------------------|------------------|--|
| Total Annual Costs | <u>\$143,000</u> |  |
|--------------------|------------------|--|

|                    |       |  |
|--------------------|-------|--|
| Benefit-Cost Ratio | 1.6:1 |  |
|--------------------|-------|--|

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<sup>1/</sup> Included in the crop budget analysis and has been deducted in the process of calculating the net income above.

TABLE 19  
Projected Capital and Annual Cost Allocations  
(in dollars)

| Purpose                                  | Cost allocations <sup>1/</sup> |   |                      | Total                |
|--|--------------------------------|---|----------------------|----------------------|
|  | P. L. 566<br>(49%)             | : | Other<br>(51%)       |                      |
| <u>Capital Costs</u>                     |                                |   |                      |                      |
| Domestic - M & I                         |                                |   |                      |                      |
| Dam and Reservoir<br>Distribution System | 0<br>0                         |   | 148,100<br>53,900    | 148,100<br>53,900    |
| Total Domestic Capital Costs             | 0                              |   | 202,000              | 202,000              |
| Irrigation - Agriculture                 |                                |   |                      |                      |
| Dam and Reservoir<br>Distribution System | 1,138,600<br>408,700           |   | 1,185,000<br>425,400 | 2,323,600<br>834,100 |
| Total Irrigation Capital Cost            | 1,547,300                      |   | 1,610,400            | 3,157,700            |
| Total Project Capital Costs              | 1,547,300                      |   | 1,812,400            | 3,359,700            |

<sup>1/</sup> Percentages supplied by Soil Conservation Service.

TABLE 19 (Continued)

| Purpose                          | Cost allocations <sup>1/</sup> |   |                | Total   |
|----------------------------------|--------------------------------|---|----------------|---------|
|                                  | P. L. 566<br>(49%)             | : | Other<br>(51%) |         |
| <u>Annual Costs<sup>2/</sup></u> |                                |   |                |         |
| Domestic - M & I                 |                                |   |                |         |
| Dam and Reservoir                | 0                              |   | 5,800          | 5,800   |
| Distribution System              | 0                              |   | 2,100          | 2,100   |
| O & M Cost - Dam and Reservoir   | 0                              |   | 100            | 100     |
| O & M Cost - Distribution System | 0                              |   | 700            | 700     |
| Total Domestic Annual Cost       | 0                              |   | 8,700          | 8,700   |
| Irrigation - Agriculture         |                                |   |                |         |
| Dam and Reservoir                | 44,200                         |   | 46,100         | 90,300  |
| Distribution System              | 15,900                         |   | 16,500         | 32,400  |
| O & M Cost - Dam and Reservoir   | 0                              |   | 2,100          | 2,100   |
| O & M Cost - Distribution System | 0                              |   | 9,500          | 9,500   |
| Total Irrigation Annual Cost     | 60,100                         |   | 74,200         | 134,300 |
| Total Project Annual Cost        | 60,100                         |   | 82,900         | 143,000 |

<sup>1/</sup> Percentages supplied by Soil Conservation Service.  
<sup>2/</sup> Average annual equivalent at 3 percent.

TABLE 19 (Continued)

| Purpose                          | Cost allocations <sup>1/</sup> |   |                | Total        |
|----------------------------------|--------------------------------|---|----------------|--------------|
|                                  | P. L. 566<br>(49%)             | : | Other<br>(51%) |              |
| <u>Water Cost</u>                |                                |   |                |              |
| <u>(Per acre-foot)</u>           |                                |   |                |              |
| Domestic                         | 0                              |   | 25.95          | 25.95        |
| Irrigation                       |                                |   |                |              |
| Dam and Reservoir                | 8.85                           |   | 9.25           | 18.10        |
| Distribution System              | 3.20                           |   | 3.30           | 6.50         |
| O & M Cost - Dam and Reservoir   | 0                              |   | 0.45           | 0.45         |
| O & M Cost - Distribution System | <u>0</u>                       |   | <u>1.90</u>    | <u>1.90</u>  |
| Total Irrigation Water Cost      | <u>12.05</u>                   |   | <u>14.90</u>   | <u>26.95</u> |
| Total Project Water Cost         | 11.30                          |   | 15.60          | 26.90        |

<sup>1/</sup> Percentages supplied by Soil Conservation Service.

TABLE 20

### Income and Outgo Payment Schedule

| Year | Water sales |          | Revenue |                    | Operating expenses |        |        |          | Net     | Unpaid balance |
|------|-------------|----------|---------|--------------------|--------------------|--------|--------|----------|---------|----------------|
|      | acre-feet   | Domestic | water   | sales @ \$40.00/AF | Domestic           | water  | total  | interest |         |                |
| 0    | -           | -        | -       | -                  | -                  | -      | -      | -        | -       | 1,812,400      |
| 1    | 1,800       | 150      | 25,650  | 6,000              | 31,650             | 12,400 | 54,370 | 66,770   | -35,120 | 0              |
| 2    | 2,350       | 150      | 33,490  | 6,000              | 39,490             | 12,400 | 55,430 | 67,830   | -28,340 | 0              |
| 3    | 2,850       | 160      | 40,610  | 6,400              | 47,010             | 12,400 | 56,280 | 68,680   | -21,670 | 0              |
| 4    | 3,200       | 170      | 45,600  | 6,800              | 52,400             | 12,400 | 56,930 | 69,330   | -16,930 | 0              |
| 5    | 3,530       | 180      | 50,300  | 7,200              | 57,500             | 12,400 | 57,430 | 69,830   | -12,330 | 0              |
| 6    | 3,850       | 180      | 54,860  | 7,200              | 62,060             | 12,400 | 57,800 | 70,200   | -8,140  | 0              |
| 7    | 4,100       | 180      | 58,430  | 7,200              | 65,630             | 12,400 | 58,050 | 70,450   | -4,820  | 0              |
| 8    | 4,400       | 190      | 62,700  | 7,600              | 70,300             | 12,400 | 58,190 | 70,590   | -290    | 0              |
| 9    | 4,650       | 190      | 66,260  | 7,600              | 73,860             | 12,400 | 58,200 | 70,600   | +3,260  | 3,260          |
| 10   | 4,900       | 190      | 69,820  | 7,600              | 77,420             | 12,400 | 58,100 | 70,500   | 6,920   | 6,920          |
| 11   | 5,200       | 200      | 74,100  | 8,000              | 82,100             | 12,400 | 57,900 | 70,300   | 11,800  | 11,800         |
| 12   | 5,400       | 200      | 76,950  | 8,000              | 84,950             | 12,400 | 57,540 | 69,940   | 15,010  | 15,010         |
| 13   | 5,600       | 210      | 79,800  | 8,400              | 88,200             | 12,400 | 57,090 | 69,490   | 18,710  | 18,710         |
| 14   | 5,890       | 210      | 83,930  | 8,400              | 92,330             | 12,400 | 56,530 | 68,930   | 23,400  | 23,400         |
| 15   | 4,940       | 220      | 70,400  | 8,800              | 79,200             | 12,400 | 55,830 | 68,230   | 10,970  | 10,970         |
| 16   | 5,890       | 220      | 83,930  | 8,800              | 92,730             | 12,400 | 55,500 | 67,900   | 24,830  | 24,830         |
| 17   | 5,890       | 220      | 83,930  | 8,800              | 92,730             | 12,400 | 54,750 | 67,150   | 25,580  | 25,580         |
| 18   | 5,890       | 230      | 83,930  | 9,200              | 93,130             | 12,400 | 53,990 | 66,390   | 26,740  | 26,740         |
| 19   | 4,300       | 240      | 61,280  | 9,600              | 70,880             | 12,400 | 53,180 | 65,580   | 5,300   | 5,300          |
| 20   | 5,890       | 250      | 83,930  | 10,000             | 93,930             | 12,400 | 53,030 | 65,430   | 28,500  | 28,500         |
| 21   | 5,890       | 260      | 83,930  | 10,400             | 94,330             | 12,400 | 52,170 | 64,570   | 29,760  | 29,760         |
| 22   | 5,890       | 270      | 83,930  | 10,800             | 94,730             | 12,400 | 51,280 | 63,680   | 31,050  | 31,050         |
| 23   | 5,890       | 280      | 83,930  | 11,200             | 95,130             | 12,400 | 50,350 | 62,750   | 32,380  | 32,380         |
| 24   | 5,890       | 290      | 83,930  | 11,600             | 95,530             | 12,400 | 49,370 | 61,770   | 33,760  | 33,760         |
| 25   | 5,890       | 300      | 83,930  | 12,000             | 95,930             | 12,400 | 48,360 | 60,760   | 35,170  | 35,170         |

### Income and Outgo Payment Schedule

| Year   | Water sales |          | Revenue           |                 | Operating expenses |           | Net       | Unpaid    |
|--------|-------------|----------|-------------------|-----------------|--------------------|-----------|-----------|-----------|
|        | acre-feet   | Domestic | Irrigation: water | Domestic: water | Interest           | Total     |           |           |
| 26     | 5,890       | 310      | 83,930            | 12,400          | 96,330             | 59,710    | 36,620    | 1,540,280 |
| 27     | 5,890       | 330      | 83,930            | 13,200          | 97,130             | 58,610    | 38,520    | 1,501,760 |
| 28     | 5,880       | 350      | 83,790            | 14,000          | 97,790             | 57,450    | 40,340    | 1,461,420 |
| 29     | 5,740       | 370      | 81,790            | 14,800          | 96,590             | 56,240    | 40,350    | 1,421,070 |
| 30     | 5,870       | 390      | 83,650            | 15,600          | 99,250             | 55,030    | 44,220    | 1,376,850 |
| 31     | 5,850       | 410      | 83,360            | 16,400          | 99,760             | 53,710    | 46,050    | 1,330,800 |
| 32     | 5,840       | 420      | 83,220            | 16,800          | 100,020            | 52,320    | 47,700    | 1,283,100 |
| 33     | 5,820       | 440      | 82,940            | 17,600          | 100,540            | 50,890    | 49,650    | 1,233,450 |
| 34     | 4,820       | 460      | 68,680            | 18,400          | 87,080             | 49,400    | 37,680    | 1,195,770 |
| 35     | 5,780       | 480      | 82,370            | 19,200          | 101,570            | 48,270    | 53,300    | 1,142,470 |
| 36     | 5,750       | 520      | 81,940            | 20,800          | 102,740            | 46,670    | 56,070    | 1,086,400 |
| 37     | 5,720       | 560      | 81,510            | 22,400          | 103,910            | 44,990    | 58,920    | 1,027,480 |
| 38     | 5,680       | 600      | 80,940            | 24,000          | 104,940            | 43,230    | 61,710    | 965,770   |
| 39     | 5,650       | 640      | 80,510            | 25,600          | 106,110            | 41,370    | 64,740    | 901,030   |
| 40     | 5,610       | 680      | 79,940            | 27,200          | 107,140            | 39,430    | 67,710    | 833,320   |
| 41     | 5,570       | 730      | 79,370            | 29,200          | 108,570            | 37,400    | 71,170    | 762,150   |
| 42     | 5,540       | 780      | 78,950            | 31,200          | 110,150            | 35,260    | 74,890    | 687,260   |
| 43     | 5,520       | 830      | 78,660            | 33,200          | 111,860            | 33,020    | 78,840    | 608,420   |
| 44     | 5,490       | 880      | 78,230            | 35,200          | 113,430            | 30,650    | 82,780    | 525,640   |
| 45     | 5,470       | 930      | 77,950            | 37,200          | 115,150            | 28,170    | 86,980    | 438,660   |
| 46     | 5,460       | 980      | 77,800            | 39,200          | 117,000            | 25,560    | 91,440    | 347,220   |
| 47     | 5,430       | 1,030    | 77,380            | 41,200          | 118,580            | 22,820    | 95,760    | 251,460   |
| 48     | 5,420       | 1,090    | 77,230            | 43,600          | 120,830            | 19,940    | 100,890   | 150,570   |
| 49     | 5,410       | 1,150    | 77,090            | 46,000          | 123,090            | 16,920    | 106,170   | 44,400    |
| 50     | 5,400       | 1,200    | 76,950            | 48,000          | 124,950            | 13,730    | 111,220   | 66,820    |
| TOTALS |             |          | 3,711,660         | 876,000         | 4,587,660          | 2,708,440 | 1,879,220 |           |

TABLE 21  
Estimated Recreation Benefits  
(by decades)

| Decade | Net decadal<br>use<br>(days) | Decadal<br>benefits <sup>1/</sup><br>(\$) | Present worth<br>factor 2/<br>: | Present<br>worth<br>benefits<br>(\$) | Average<br>annual<br>equivalent<br>(\$) |
|--------|------------------------------|---|---------------------------------|--------------------------------------|---|
| 1      | 600,000                      | 300,000                                   | 0.8626                          | 258,780                              |   |
| 2      | 500,000                      | 250,000                                   | 0.6418                          | 160,475                              |   |
| 3      | 500,000                      | 250,000                                   | 0.4776                          | 119,400                              |   |
| 4      | 500,000                      | 250,000                                   | 0.3554                          | 88,850                               |   |
| 5      | 500,000                      | 250,000                                   | 0.2644                          | 66,100                               |   |
| TOTAL  | 2,600,000                    | 1,300,000                                 |                                 | 693,605                              | 26,960                                  |

<sup>1/</sup> Based on \$0.50 per visitor-day, which is the minimum value used by the Department for day use.

<sup>2/</sup> Present worth factor at 3 percent interest rate.

TABLE 22

## Economic and Financial Summary at Full Development

## Payment Capacity

|                           |              |               |
|---------------------------|--------------|---------------|
| Gross Income              |              | \$ 338.55     |
| Production Costs          | \$ 260.00    |               |
| Management Charge         | <u>33.85</u> |               |
| Total Costs               |              | <u>293.85</u> |
| Payment capacity per acre |              | 44.70         |
| Per acre-foot             |              | 26.30         |

## Net Farm Income

## 1. Project Conditions

|                  | <u>Basic</u> <u>1/</u> | <u>Adjusted</u> <u>2/</u> |
|------------------|------------------------|---------------------------|
| Gross Income     | \$ 338.55              | \$ 314.85                 |
| Production Costs | \$234.80               | \$220.70                  |
| Water Costs      | <u>24.20</u>           | <u>24.20</u>              |
| Total Costs      | <u>259.00</u>          | <u>244.90</u>             |
| Net Income       | 79.55                  | 69.95                     |

## 2. Nonproject Conditions

|                  |              |              |
|------------------|--------------|--------------|
| Gross Income     | 26.20        | 24.40        |
| Production Costs | <u>18.30</u> | <u>17.20</u> |
| Net Income       | 7.90         | 7.20         |
| Net Farm Income  | \$ 71.65     | \$ 62.75     |

1/ Based on 1952-56 economic conditions.2/ Adjusted to reflect the relationship of the projected future and the base period prices received and prices paid.



APPENDIX G

MONTHLY OPERATION STUDY

OF

COLLAYOMI RESERVOIR



**MONTHLY OPERATION STUDY  
COLLAYOMI RESERVOIR  
(in acre-feet)**

Gross storage: 6,600 acre-feet  
Active storage: 6,000 acre-feet

| Year         | Unimpaired: Gross storage | Met                                 | Releases | Spill or |
|--------------|---------------------------|-------------------------------------|----------|----------|
| and : inflow | : on first of             | evapora-Agricul-: Urban : shortages |          |          |
| month: 1/    | : month                   | : tion                              | : tural  | : 3/     |
| 1906         |                           |                                     |          |          |
| Jan          | 17,500                    | 6,600                               | 0        | 10       |
| Feb          | 6,400                     | 6,600                               | 0        | 10       |
| Mar          | 8,600                     | 6,600                               | 0        | 10       |
| Apr          | 3,000                     | 6,600                               | 10       | 200      |
| May          | 2,200                     | 6,600                               | 40       | 200      |
| June         | 1,700                     | 6,600                               | 70       | 490      |
| July         | 310                       | 6,600                               | 100      | 540      |
| Aug          | 130                       | 6,250                               | 100      | 410      |
| Sept         | 100                       | 5,850                               | 70       | 160      |
| Oct          | 50                        | 5,710                               | 20       | 10       |
| Nov          | 120                       | 5,730                               | -10      | 10       |
| Dec          | 2,650                     | 5,850                               | -20      | 10       |
| Total        | 42,760                    | 380                                 | 1,800    | 150      |
| 1907         |                           |                                     |          |          |
| Jan          | 7,800                     | 6,600                               | 0        | 10       |
| Feb          | 5,800                     | 6,600                               | 0        | 10       |
| Mar          | 16,500                    | 6,600                               | 0        | 10       |
| Apr          | 3,500                     | 6,600                               | 10       | 10       |
| May          | 900                       | 6,600                               | 40       | 260      |
| June         | 420                       | 6,600                               | 70       | 630      |
| July         | 180                       | 6,300                               | 100      | 710      |
| Aug          | 40                        | 5,650                               | 90       | 540      |
| Sept         | 30                        | 5,040                               | 60       | 210      |
| Oct          | 120                       | 4,790                               | 20       | 10       |
| Nov          | 130                       | 4,880                               | -10      | 10       |
| Dec          | 1,150                     | 5,010                               | -20      | 10       |
| Total        | 36,570                    | 360                                 | 2,350    | 150      |
| 1908         |                           |                                     |          |          |
| Jan          | 3,900                     | 6,170                               | 0        | 10       |
| Feb          | 6,000                     | 6,600                               | 0        | 10       |
| Mar          | 3,400                     | 6,600                               | 0        | 10       |
| Apr          | 700                       | 6,600                               | 10       | 10       |
| May          | 380                       | 6,600                               | 40       | 310      |
| June         | 180                       | 6,600                               | 70       | 770      |
| July         | 20                        | 5,920                               | 100      | 850      |
| Aug          | 10                        | 4,970                               | 90       | 660      |
| Sept         | 0                         | 4,210                               | 50       | 260      |
| Oct          | 0                         | 3,880                               | 20       | 10       |
| Nov          | 30                        | 3,850                               | -10      | 10       |
| Dec          | 500                       | 3,880                               | -20      | 10       |
| Total        | 15,120                    | 350                                 | 2,850    | 160      |
| 1909         |                           |                                     |          |          |
| Jan          | 22,000                    | 4,390                               | 0        | 10       |
| Feb          | 15,300                    | 6,600                               | 0        | 10       |
| Mar          | 4,000                     | 6,600                               | 0        | 10       |
| Apr          | 1,500                     | 6,600                               | 10       | 10       |
| May          | 520                       | 6,600                               | 40       | 350      |
| June         | 270                       | 6,600                               | 70       | 860      |
| July         | 60                        | 5,920                               | 100      | 960      |
| Aug          | 10                        | 4,890                               | 90       | 740      |
| Sept         | 10                        | 4,060                               | 50       | 290      |
| Oct          | 100                       | 3,710                               | 20       | 10       |
| Nov          | 300                       | 3,780                               | -10      | 10       |
| Dec          | 3,400                     | 4,080                               | -20      | 10       |
| Total        | 47,480                    | 350                                 | 3,200    | 170      |
| 1910         |                           |                                     |          |          |
| Jan          | 5,100                     | 6,600                               | 0        | 10       |
| Feb          | 2,700                     | 6,600                               | 0        | 10       |
| Mar          | 3,600                     | 6,600                               | 0        | 10       |
| Apr          | 1,450                     | 6,600                               | 10       | 10       |
| May          | 480                       | 6,600                               | 40       | 390      |
| June         | 140                       | 6,600                               | 70       | 950      |
| July         | 40                        | 5,700                               | 90       | 1,060    |
| Aug          | 10                        | 4,560                               | 80       | 810      |
| Sept         | 0                         | 3,650                               | 50       | 320      |
| Oct          | 0                         | 3,260                               | 20       | 10       |
| Nov          | 50                        | 3,230                               | 0        | 10       |
| Dec          | 120                       | 3,270                               | -20      | 10       |
| Total        | 13,690                    | 340                                 | 3,530    | 180      |
| 1911         |                           |                                     |          |          |
| Jan          | 8,800                     | 3,400                               | 0        | 10       |
| Feb          | 5,100                     | 6,600                               | 0        | 10       |
| Mar          | 12,400                    | 6,600                               | 0        | 10       |
| Apr          | 2,100                     | 6,600                               | 10       | 10       |
| May          | 800                       | 6,600                               | 40       | 420      |
| June         | 230                       | 6,600                               | 70       | 1,040    |
| July         | 60                        | 5,700                               | 90       | 1,150    |
| Aug          | 20                        | 4,490                               | 80       | 890      |
| Sept         | 0                         | 3,510                               | 50       | 350      |
| Oct          | 100                       | 3,090                               | 20       | 10       |
| Nov          | 120                       | 3,160                               | 0        | 10       |
| Dec          | 170                       | 3,270                               | -20      | 10       |
| Total        | 29,900                    | 340                                 | 3,850    | 180      |
| 1912         |                           |                                     |          |          |
| Jan          | 8,800                     | 3,400                               | 0        | 10       |
| Feb          | 5,100                     | 6,600                               | 0        | 10       |
| Mar          | 12,400                    | 6,600                               | 0        | 10       |
| Apr          | 2,100                     | 6,600                               | 10       | 10       |
| May          | 800                       | 6,600                               | 40       | 420      |
| June         | 230                       | 6,600                               | 70       | 1,040    |
| July         | 60                        | 5,700                               | 90       | 1,150    |
| Aug          | 20                        | 4,490                               | 80       | 890      |
| Sept         | 0                         | 3,510                               | 50       | 350      |
| Oct          | 100                       | 3,090                               | 20       | 10       |
| Nov          | 120                       | 3,160                               | 0        | 10       |
| Dec          | 170                       | 3,270                               | -20      | 10       |
| Total        | 29,900                    | 340                                 | 3,850    | 180      |

## APPENDIX G (continued)

MONTHLY OPERATION STUDY  
COLLAYOMI RESERVOIR  
(in acre-feet)Gross storage: 6,600 acre-feet  
Active storage: 6,000 acre-feet

| Year         | Unimpaired: | Gross storage: | Met      | Releases | Spill or  |
|--------------|-------------|----------------|----------|----------|-----------|
| and : inflow | on first of | evapora-       | Agricul- | Urban    | shortages |
| month:       | 1/          | month          | tion     | tural    | 3/        |
| 1912         |             |                |          |          |           |
| Jan          | 1,500       | 3,450          | 0        | 10       | 10        |
| Feb          | 4,450       | 4,940          | 0        | 10       | 10        |
| Mar          | 2,400       | 5,380          | 0        | 10       | 1,170     |
| Apr          | 620         | 6,600          | 10       | 10       | 600       |
| May          | 700         | 6,600          | 40       | 10       | 200       |
| June         | 140         | 6,600          | 70       | 1,110    | 20        |
| July         | 40          | 5,540          | 90       | 1,230    | 30        |
| Aug          | 10          | 4,230          | 80       | 940      | 30        |
| Sept         | 0           | 3,190          | 50       | 370      | 20        |
| Oct          | 60          | 2,750          | 20       |          | 10        |
| Nov          | 770         | 2,780          | 0        |          | 10        |
| Dec          | 550         | 3,540          | -20      |          | 10        |
| Total        | 7,240       |                | 340      | 4,100    | 180       |
| 1913         |             |                |          |          |           |
| Jan          | 7,250       | 4,100          | 0        | 10       | 4,740     |
| Feb          | 820         | 6,600          | 0        | 10       | 810       |
| Mar          | 800         | 6,600          | 0        | 10       | 790       |
| Apr          | 760         | 6,600          | 10       | 10       | 740       |
| May          | 230         | 6,600          | 40       | 480      |           |
| June         | 40          | 6,290          | 70       | 1,190    | 20        |
| July         | 20          | 5,050          | 90       | 1,320    | 30        |
| Aug          | 0           | 3,630          | 70       | 1,010    | 30        |
| Sept         | 0           | 2,520          | 40       | 400      | 20        |
| Oct          | 0           | 2,060          | 10       |          | 10        |
| Nov          | 400         | 2,040          | 0        |          | 10        |
| Dec          | 8,300       | 2,430          | -10      |          | 4,130     |
| Total        | 18,620      |                | 320      | 4,400    | 190       |
| 1914         |             |                |          |          |           |
| Jan          | 23,000      | 6,600          | 0        | 10       | 22,990    |
| Feb          | 8,600       | 6,600          | 0        | 10       | 8,590     |
| Mar          | 2,600       | 6,600          | 0        | 10       | 2,590     |
| Apr          | 1,500       | 6,600          | 10       | 10       | 1,480     |
| May          | 600         | 6,600          | 40       | 510      | 30        |
| June         | 230         | 6,600          | 70       | 1,260    | 20        |
| July         | 60          | 5,480          | 90       | 1,390    | 30        |
| Aug          | 20          | 4,030          | 80       | 1,070    | 30        |
| Sept         | 0           | 2,870          | 50       | 420      | 20        |
| Oct          | 40          | 2,380          | 10       |          | 10        |
| Nov          | 30          | 2,400          | 0        |          | 10        |
| Dec          | 600         | 2,420          | -10      |          | 10        |
| Total        | 37,280      |                | 340      | 4,650    | 190       |

| Year         | Unimpaired: | Gross storage: | Met      | Releases | Spill or  |
|--------------|-------------|----------------|----------|----------|-----------|
| and : inflow | on first of | evapora-       | Agricul- | Urban    | shortages |
| month:       | 1/          | month          | tion     | tural    | 3/        |
| 1915         |             |                |          |          |           |
| Jan          | 6,400       | 3,020          | 0        | 10       | 2,810     |
| Feb          | 19,500      | 6,600          | 0        | 10       | 19,490    |
| Mar          | 6,000       | 6,600          | 0        | 10       | 5,990     |
| Apr          | 2,500       | 6,600          | 10       | 10       | 2,480     |
| May          | 2,500       | 6,600          | 40       | 540      | 1,900     |
| June         | 620         | 6,600          | 70       | 1,320    | 20        |
| July         | 220         | 5,810          | 100      | 1,470    | 30        |
| Aug          | 100         | 4,430          | 80       | 1,130    | 30        |
| Sept         | 40          | 3,290          | 50       | 440      | 20        |
| Oct          | 60          | 2,820          | 20       |          | 10        |
| Nov          | 80          | 2,850          | 0        |          | 10        |
| Dec          | 4,700       | 2,920          | -20      |          | 1,030     |
| Total        | 42,720      |                | 350      | 4,900    | 190       |
| 1916         |             |                |          |          |           |
| Jan          | 21,000      | 6,600          | 0        | 10       | 20,990    |
| Feb          | 5,900       | 6,600          | 0        | 10       | 5,890     |
| Mar          | 4,000       | 6,600          | 0        | 10       | 3,990     |
| Apr          | 1,100       | 6,600          | 10       | 10       | 1,080     |
| May          | 600         | 6,600          | 40       | 570      | 20        |
| June         | 300         | 6,570          | 70       | 1,400    | 20        |
| July         | 60          | 5,380          | 90       | 1,560    | 30        |
| Aug          | 20          | 3,760          | 80       | 1,200    | 30        |
| Sept         | 20          | 2,470          | 40       | 470      | 20        |
| Oct          | 80          | 1,960          | 10       |          | 20        |
| Nov          | 90          | 2,010          | 0        |          | 10        |
| Dec          | 2,150       | 2,090          | -10      |          | 10        |
| Total        | 35,320      |                | 330      | 5,200    | 200       |
| 1917         |             |                |          |          |           |
| Jan          | 1,900       | 4,240          | 0        | 10       | 10,720    |
| Feb          | 11,200      | 6,130          | 0        | 10       | 2,590     |
| Mar          | 2,600       | 6,600          | 0        | 10       | 1,280     |
| Apr          | 1,300       | 6,600          | 10       | 10       | 20        |
| May          | 530         | 6,600          | 40       | 590      | 20        |
| June         | 160         | 6,480          | 70       | 1,460    | 20        |
| July         | 70          | 5,090          | 90       | 1,620    | 30        |
| Aug          | 10          | 3,420          | 70       | 1,240    | 30        |
| Sept         | 10          | 2,090          | 40       | 490      | 20        |
| Oct          | 40          | 1,550          | 10       |          | 20        |
| Nov          | 60          | 1,560          | 0        |          | 10        |
| Dec          | 140         | 1,610          | -10      |          | 10        |
| Total        | 18,020      |                | 320      | 5,400    | 200       |

**MONTHLY OPERATION STUDY**  
COLLAYOMI RESERVOIR  
(in acre-feet)

Gross storage: 6,600 acre-feet  
Active storage: 6,000 acre-feet

| Year : Unimpaired: Gross storage: Met : Releases 2/ :<br>and : inflow : on first of : evapora-: Agricul-: Urban : spill or<br>month: 1/ : month : tion : tural : : shortages<br>3/ |        |       |     |     |     |  |  |  |  |  |  |        |
|--|--------|-------|-----|-----|-----|--|--|--|--|--|--|--------|
| 1918   | 160    | 1,750 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Jan  | 160    | 1,750 | 0   | 0   | 10  |  |  |  |  |  |  | 14,150 |
| Feb  | 3,400  | 1,900 | 0   | 0   | 10  |  |  |  |  |  |  | 3,460  |
| Mar  | 3,600  | 5,290 | 0   | 0   | 10  |  |  |  |  |  |  | 1,840  |
| Apr  | 900    | 6,600 | 10  | 10  | 10  |  |  |  |  |  |  | 750    |
| May  | 250    | 6,600 | 40  | 40  | 20  |  |  |  |  |  |  |        |
| June   | 80     | 6,170 | 70  | 70  | 30  |  |  |  |  |  |  |        |
| July   | 40     | 4,640 | 80  | 80  | 30  |  |  |  |  |  |  |        |
| Aug  | 20     | 2,890 | 70  | 70  | 30  |  |  |  |  |  |  |        |
| Sept   | 0      | 1,520 | 30  | 30  | 20  |  |  |  |  |  |  |        |
| Oct  | 20     | 970   | 10  | 10  | 20  |  |  |  |  |  |  |        |
| Nov  | 150    | 960   | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Dec  | 150    | 1,000 | -10 | -10 | 10  |  |  |  |  |  |  |        |
| Total  | 8,670  |       | 300 | 300 | 210 |  |  |  |  |  |  |        |
| 1919   | 2,040  | 1,150 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Jan  | 2,040  | 1,150 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Feb  | 13,620 | 3,180 | 0   | 0   | 10  |  |  |  |  |  |  | 7,620  |
| Mar  | 5,200  | 2,600 | 0   | 0   | 10  |  |  |  |  |  |  | 2,810  |
| Apr  | 790    | 6,600 | 10  | 10  | 10  |  |  |  |  |  |  | 1,200  |
| May  | 340    | 6,600 | 40  | 40  | 20  |  |  |  |  |  |  |        |
| June   | 100    | 6,240 | 70  | 70  | 30  |  |  |  |  |  |  |        |
| July   | 10     | 4,660 | 80  | 80  | 30  |  |  |  |  |  |  |        |
| Aug  | 0      | 2,800 | 70  | 70  | 30  |  |  |  |  |  |  |        |
| Sept   | 0      | 1,350 | 30  | 30  | 20  |  |  |  |  |  |  |        |
| Oct  | 20     | 770   | 10  | 10  | 20  |  |  |  |  |  |  |        |
| Nov  | 50     | 760   | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Dec  | 220    | 800   | -10 | -10 | 10  |  |  |  |  |  |  |        |
| Total  | 22,390 |       | 300 | 300 | 210 |  |  |  |  |  |  |        |
| 1920   | 150    | 1,020 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Jan  | 150    | 1,020 | 0   | 0   | 10  |  |  |  |  |  |  | 4,080  |
| Feb  | 130    | 1,160 | 0   | 0   | 10  |  |  |  |  |  |  | 1,850  |
| Mar  | 1,160  | 1,280 | 0   | 0   | 10  |  |  |  |  |  |  | 720    |
| Apr  | 2,650  | 2,430 | 0   | 0   | 10  |  |  |  |  |  |  | 2,370  |
| May  | 460    | 5,070 | 30  | 30  | 20  |  |  |  |  |  |  |        |
| June   | 170    | 4,830 | 60  | 60  | 30  |  |  |  |  |  |  |        |
| July   | 30     | 3,320 | 70  | 70  | 40  |  |  |  |  |  |  |        |
| Aug  | 0      | 1,470 | 40  | 40  | 30  |  |  |  |  |  |  |        |
| Sept   | 210    | 1,680 | 10  | 10  | 20  |  |  |  |  |  |  |        |
| Oct  | 0      | 630   | 0   | 0   | 20  |  |  |  |  |  |  |        |
| Nov  | 4,040  | 610   | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Dec  | 7,500  | 4,640 | -20 | -20 | 10  |  |  |  |  |  |  |        |
| Total  | 16,500 |       | 190 | 190 | 220 |  |  |  |  |  |  |        |
| 1921   | 14,160 | 6,600 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Jan  | 14,160 | 6,600 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Feb  | 3,470  | 6,600 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Mar  | 1,850  | 6,600 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Apr  | 770    | 6,600 | 10  | 10  | 10  |  |  |  |  |  |  |        |
| May  | 360    | 6,600 | 40  | 40  | 20  |  |  |  |  |  |  |        |
| June   | 150    | 6,250 | 70  | 70  | 30  |  |  |  |  |  |  |        |
| July   | 20     | 4,710 | 80  | 80  | 40  |  |  |  |  |  |  |        |
| Aug  | 0      | 2,840 | 70  | 70  | 30  |  |  |  |  |  |  |        |
| Sept   | 0      | 1,390 | 30  | 30  | 20  |  |  |  |  |  |  |        |
| Oct  | 10     | 810   | 10  | 10  | 20  |  |  |  |  |  |  |        |
| Nov  | 120    | 790   | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Dec  | 2,730  | 900   | -10 | -10 | 10  |  |  |  |  |  |  |        |
| Total  | 23,640 |       | 300 | 300 | 220 |  |  |  |  |  |  |        |
| 1922   | 730    | 3,630 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Jan  | 730    | 3,630 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Feb  | 9,880  | 4,350 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Mar  | 2,820  | 6,600 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Apr  | 1,220  | 6,600 | 10  | 10  | 10  |  |  |  |  |  |  |        |
| May  | 290    | 6,600 | 40  | 40  | 20  |  |  |  |  |  |  |        |
| June   | 80     | 6,180 | 70  | 70  | 30  |  |  |  |  |  |  |        |
| July   | 10     | 4,570 | 80  | 80  | 40  |  |  |  |  |  |  |        |
| Aug  | 0      | 2,690 | 60  | 60  | 30  |  |  |  |  |  |  |        |
| Sept   | 0      | 1,250 | 30  | 30  | 20  |  |  |  |  |  |  |        |
| Oct  | 170    | 670   | 0   | 0   | 20  |  |  |  |  |  |  |        |
| Nov  | 1,050  | 820   | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Dec  | 10,100 | 1,860 | -10 | -10 | 10  |  |  |  |  |  |  |        |
| Total  | 26,350 |       | 280 | 280 | 220 |  |  |  |  |  |  |        |
| 1923   | 4,090  | 6,600 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Jan  | 4,090  | 6,600 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Feb  | 1,860  | 6,600 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Mar  | 770    | 6,600 | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Apr  | 2,390  | 6,600 | 10  | 10  | 10  |  |  |  |  |  |  |        |
| May  | 410    | 6,600 | 40  | 40  | 20  |  |  |  |  |  |  |        |
| June   | 150    | 6,300 | 70  | 70  | 30  |  |  |  |  |  |  |        |
| July   | 20     | 4,760 | 80  | 80  | 40  |  |  |  |  |  |  |        |
| Aug  | 0      | 2,890 | 70  | 70  | 30  |  |  |  |  |  |  |        |
| Sept   | 20     | 1,440 | 30  | 30  | 20  |  |  |  |  |  |  |        |
| Oct  | 0      | 870   | 10  | 10  | 20  |  |  |  |  |  |  |        |
| Nov  | 10     | 840   | 0   | 0   | 10  |  |  |  |  |  |  |        |
| Dec  | 90     | 840   | -10 | -10 | 10  |  |  |  |  |  |  |        |
| Total  | 9,810  |       | 300 | 300 | 230 |  |  |  |  |  |  |        |

## APPENDIX G (continued)

MONTHLY OPERATION STUDY  
COLLAYOMI RESERVOIR  
(in acre-feet)

Gross storage: 6,600 acre-feet  
Active storage: 6,000 acre-feet

| Year  | Unimpaired: Gross storage: Met        | Releases 2/ | Spill or |
|---|---------------------------------------|-------------|----------|
| and : inflow : on first of : Agricultural : Urban : shortages | month: 1/ : month : tion : tural : 3/ |             |          |
| 1924  |                                       |             |          |
| Jan   | 500                                   | 930         | 10       |
| Feb   | 3,360                                 | 1,420       | 10       |
| Mar   | 3,410                                 | 4,770       | 10       |
| Apr   | 140                                   | 5,170       | 10       |
| May   | 20                                    | 5,290       | 20       |
| June  | 0                                     | 4,600       | 30       |
| July  | 0                                     | 2,920       | 40       |
| Aug   | 0                                     | 1,040       | 30       |
| Sept  | 0                                     | 670         | 30       |
| Oct   | 440                                   | 630         | 20       |
| Nov   | 630                                   | 1,050       | 10       |
| Dec   | 1,960                                 | 1,670       | 10       |
| Total   | 7,460                                 | 210         | 240      |
| 1925  |                                       |             |          |
| Jan   | 870                                   | 3,630       | 10       |
| Feb   | 14,400                                | 4,490       | 10       |
| Mar   | 2,040                                 | 6,600       | 10       |
| Apr   | 2,290                                 | 6,600       | 20       |
| May   | 1,680                                 | 6,600       | 20       |
| June  | 1,530                                 | 6,600       | 30       |
| July  | 200                                   | 5,440       | 40       |
| Aug   | 40                                    | 3,740       | 40       |
| Sept  | 10                                    | 2,320       | 30       |
| Oct   | 0                                     | 1,730       | 20       |
| Nov   | 150                                   | 1,700       | 10       |
| Dec   | 100                                   | 1,840       | 10       |
| Total   | 22,400                                | 320         | 250      |
| 1926  |                                       |             |          |
| Jan   | 2,630                                 | 2,030       | 10       |
| Feb   | 11,350                                | 4,650       | 10       |
| Mar   | 1,100                                 | 6,600       | 10       |
| Apr   | 8,260                                 | 6,600       | 20       |
| May   | 600                                   | 6,600       | 20       |
| June  | 170                                   | 6,490       | 30       |
| July  | 30                                    | 4,970       | 40       |
| Aug   | 0                                     | 3,100       | 40       |
| Sept  | 0                                     | 1,640       | 30       |
| Oct   | 40                                    | 1,050       | 20       |
| Nov   | 4,010                                 | 1,060       | 20       |
| Dec   | 2,500                                 | 5,050       | 10       |
| Total   | 30,690                                | 300         | 260      |
| 1927  |                                       |             |          |
| Jan   | 3,720                                 | 6,600       | 10       |
| Feb   | 14,000                                | 6,600       | 10       |
| Mar   | 2,530                                 | 6,600       | 10       |
| Apr   | 6,100                                 | 6,600       | 20       |
| May   | 650                                   | 6,600       | 20       |
| June  | 270                                   | 6,540       | 40       |
| July  | 70                                    | 5,110       | 40       |
| Aug   | 10                                    | 3,280       | 40       |
| Sept  | 0                                     | 1,830       | 30       |
| Oct   | 20                                    | 1,230       | 20       |
| Nov   | 8,500                                 | 1,220       | 20       |
| Dec   | 1,880                                 | 6,600       | 10       |
| Total   | 37,750                                | 300         | 270      |
| 1928  |                                       |             |          |
| Jan   | 2,160                                 | 6,600       | 10       |
| Feb   | 4,810                                 | 6,600       | 10       |
| Mar   | 7,060                                 | 6,600       | 10       |
| Apr   | 3,500                                 | 6,600       | 20       |
| May   | 580                                   | 6,600       | 30       |
| June  | 150                                   | 6,460       | 40       |
| July  | 20                                    | 4,880       | 40       |
| Aug   | 0                                     | 3,000       | 40       |
| Sept  | 0                                     | 1,540       | 30       |
| Oct   | 0                                     | 950         | 20       |
| Nov   | 170                                   | 920         | 20       |
| Dec   | 1,420                                 | 1,070       | 10       |
| Total   | 19,870                                | 340         | 280      |
| 1929  |                                       |             |          |
| Jan   | 700                                   | 2,490       | 10       |
| Feb   | 3,240                                 | 3,180       | 10       |
| Mar   | 1,040                                 | 6,410       | 10       |
| Apr   | 460                                   | 6,600       | 20       |
| May   | 240                                   | 6,600       | 30       |
| June  | 80                                    | 6,120       | 40       |
| July  | 10                                    | 4,500       | 50       |
| Aug   | 0                                     | 2,610       | 40       |
| Sept  | 0                                     | 1,160       | 30       |
| Oct   | 0                                     | 640         | 20       |
| Nov   | 0                                     | 620         | 20       |
| Dec   | 7,920                                 | 600         | 10       |
| Total   | 13,690                                | 280         | 290      |

**MONTHLY OPERATION STUDY**  
COLLAYOMI RESERVOIR  
(in acre-feet)

Gross storage: 6,600 acre-feet  
Active storage: 6,000 acre-feet

| Year : Unimpaired Gross storage : Net : Releases 2/ : Spill or<br>and : inflow : on first of September - Agricultural - Urban : shortages<br>month: 1/ : month : tion : tural : : 3/ |               |       |            |            |        |               |       |            |            |
|--|---------------|-------|------------|------------|--------|---------------|-------|------------|------------|
| <b>1933</b>  |               |       |            |            |        |               |       |            |            |
| Jan  | 5,440         | 6,600 | 0          | 10         | 5,430  | 3,050         | 1,020 | 0          | 20         |
| Feb  | 3,880         | 6,600 | 0          | 10         | 3,870  | 1,180         | 4,050 | 0          | 10         |
| Mar  | 4,510         | 6,600 | 0          | 10         | 4,500  | 2,650         | 5,220 | 0          | 20         |
| Apr  | 850           | 6,600 | 10         | 20         | 820    | 850           | 6,600 | 10         | 20         |
| May  | 410           | 6,600 | 40         | 30         |        | 560           | 6,600 | 40         | 30         |
| June   | 150           | 6,290 | 70         | 30         |        | 150           | 6,440 | 70         | 40         |
| July   | 20            | 4,740 | 80         | 50         |        | 30            | 4,890 | 90         | 50         |
| Aug  | 0             | 2,860 | 70         | 40         |        | 0             | 3,010 | 70         | 50         |
| Sept   | 0             | 1,400 | 30         | 30         |        | 0             | 1,540 | 30         | 40         |
| Oct  | 10            | 810   | 10         | 30         |        | 0             | 940   | 10         | 30         |
| Nov  | 60            | 780   | 0          | 20         |        | 0             | 900   | 0          | 20         |
| Dec  | 50            | 820   | -10        | 10         |        | 4,520         | 880   | -10        | 20         |
| <b>Total</b>   | <b>15,380</b> |       | <b>300</b> | <b>300</b> |        | <b>12,990</b> |       | <b>310</b> | <b>350</b> |
| <b>1934</b>  |               |       |            |            |        |               |       |            |            |
| Jan  | 1,750         | 870   | 0          | 10         |        | 2,500         | 5,390 | 0          | 20         |
| Feb  | 500           | 2,610 | 0          | 10         |        | 3,660         | 6,600 | 0          | 10         |
| Mar  | 1,200         | 3,100 | 0          | 10         |        | 1,430         | 6,600 | 0          | 20         |
| Apr  | 290           | 4,290 | 10         | 20         |        | 490           | 6,600 | 10         | 20         |
| May  | 90            | 4,550 | 30         | 30         |        | 230           | 6,600 | 40         | 30         |
| June   | 50            | 3,930 | 50         | 40         |        | 50            | 6,110 | 70         | 50         |
| July   | 0             | 2,300 | 60         | 50         | -350   | 10            | 4,460 | 80         | 60         |
| Aug  | 0             | 770   | 30         | 50         | -1,350 | 0             | 2,570 | 60         | 50         |
| Sept   | 0             | 690   | 10         | 30         | -530   | 0             | 1,110 | 20         | 40         |
| Oct  | 60            | 650   | 0          | 30         |        | 0             | 650   | 0          | 30         |
| Nov  | 0             | 680   | 0          | 20         |        | 780           | 620   | 0          | 20         |
| Dec  | 7,020         | 660   | 0          | 10         | 1,070  | 540           | 1,380 | -10        | 20         |
| <b>Total</b>   | <b>10,960</b> |       | <b>190</b> | <b>310</b> |        | <b>9,690</b>  |       | <b>270</b> | <b>370</b> |
| <b>1935</b>  |               |       |            |            |        |               |       |            |            |
| Jan  | 2,840         | 6,600 | 0          | 10         | 2,830  | 8,040         | 1,910 | 0          | 20         |
| Feb  | 2,090         | 6,600 | 0          | 10         | 2,080  | 1,860         | 6,600 | 0          | 20         |
| Mar  | 630           | 6,600 | 0          | 10         | 620    | 6,350         | 6,600 | 0          | 20         |
| Apr  | 430           | 6,600 | 10         | 20         | 400    | 4,550         | 6,600 | 10         | 20         |
| May  | 450           | 6,600 | 40         | 30         |        | 750           | 6,600 | 40         | 30         |
| June   | 210           | 6,330 | 70         | 40         |        | 190           | 6,600 | 70         | 50         |
| July   | 40            | 4,840 | 90         | 50         |        | 40            | 5,090 | 90         | 60         |
| Aug  | 0             | 2,970 | 70         | 50         |        | 0             | 3,220 | 70         | 60         |
| Sept   | 0             | 1,500 | 30         | 40         |        | 0             | 1,740 | 30         | 40         |
| Oct  | 0             | 900   | 10         | 30         |        | 0             | 1,140 | 10         | 30         |
| Nov  | 190           | 860   | 0          | 20         |        | 0             | 1,100 | 0          | 20         |
| Dec  | 190           | 840   | -10        | 20         |        | 0             | 1,080 | -10        | 20         |
| <b>Total</b>   | <b>6,880</b>  |       | <b>310</b> | <b>330</b> |        | <b>21,780</b> |       | <b>310</b> | <b>390</b> |

## APPENDIX G (continued)

MONTHLY OPERATION STUDY  
COLLAYOMI RESERVOIR  
(in acre-feet)Gross storage: 6,600 acre-feet  
Active storage: 6,000 acre-feet

| Year and month: | Unimpaired inflow 1/ | Gross storage on first of month | Met evaporation 1/ | Releases 2/ | Met evaporation 1/ | Urban shortages 3/ | Spill or shortages 3/ |
|-----------------|----------------------|---------------------------------|--------------------|-------------|--------------------|--------------------|-----------------------|
| 1936            |                      |                                 |                    |             |                    |                    |                       |
| Jan             | 6,270                | 1,070                           | 0                  | 20          | 720                |                    |                       |
| Feb             | 14,190               | 6,600                           | 0                  | 20          | 14,170             |                    |                       |
| Mar             | 1,790                | 6,600                           | 0                  | 20          | 1,770              |                    |                       |
| Apr             | 2,190                | 6,600                           | 10                 | 30          | 2,150              |                    |                       |
| May             | 440                  | 6,600                           | 40                 | 30          |                    |                    |                       |
| June            | 300                  | 6,330                           | 70                 | 50          |                    |                    |                       |
| July            | 80                   | 4,930                           | 90                 | 60          | 1,580              |                    |                       |
| Aug             | 10                   | 3,100                           | 70                 | 60          | 1,760              |                    |                       |
| Sept            | 0                    | 1,640                           | 30                 | 40          | 1,340              |                    |                       |
| Oct             | 0                    | 1,040                           | 10                 | 30          | 530                |                    |                       |
| Nov             | 0                    | 1,000                           | 0                  | 30          |                    |                    |                       |
| Dec             | 0                    | 970                             | -10                | 20          |                    |                    |                       |
| Total           | 25,270               |                                 | 310                | 5,850       | 410                |                    |                       |
| 1937            |                      |                                 |                    |             |                    |                    |                       |
| Jan             | 610                  | 960                             | 0                  | 20          |                    |                    |                       |
| Feb             | 9,400                | 1,550                           | 0                  | 20          | 4,330              |                    |                       |
| Mar             | 5,420                | 6,600                           | 0                  | 20          | 5,400              |                    |                       |
| Apr             | 1,520                | 6,600                           | 10                 | 30          | 1,480              |                    |                       |
| May             | 480                  | 6,600                           | 40                 | 30          |                    |                    |                       |
| June            | 260                  | 6,370                           | 70                 | 50          | 640                |                    |                       |
| July            | 60                   | 4,930                           | 90                 | 60          | 1,580              |                    |                       |
| Aug             | 10                   | 3,090                           | 70                 | 60          | 1,750              |                    |                       |
| Sept            | 0                    | 1,630                           | 30                 | 50          | 1,340              |                    |                       |
| Oct             | 0                    | 1,050                           | 10                 | 30          | 530                |                    |                       |
| Nov             | 3,050                | 980                             | 0                  | 30          |                    |                    |                       |
| Dec             | 12,250               | 4,000                           | -20                | 20          | 9,650              |                    |                       |
| Total           | 33,060               |                                 | 300                | 5,840       | 420                |                    |                       |
| 1938            |                      |                                 |                    |             |                    |                    |                       |
| Jan             | 3,670                | 6,600                           | 0                  | 20          | 3,650              |                    |                       |
| Feb             | 18,010               | 6,600                           | 0                  | 20          | 17,990             |                    |                       |
| Mar             | 12,930               | 6,600                           | 0                  | 20          | 12,910             |                    |                       |
| Apr             | 2,730                | 6,600                           | 10                 | 30          | 2,690              |                    |                       |
| May             | 800                  | 6,600                           | 40                 | 40          | 640                |                    |                       |
| June            | 270                  | 6,600                           | 70                 | 60          | 1,570              |                    |                       |
| July            | 70                   | 5,170                           | 80                 | 70          | 1,750              |                    |                       |
| Aug             | 10                   | 3,340                           | 70                 | 60          | 1,340              |                    |                       |
| Sept            | 0                    | 1,880                           | 30                 | 50          | 520                |                    |                       |
| Oct             | 20                   | 1,280                           | 10                 | 30          |                    |                    |                       |
| Nov             | 440                  | 1,260                           | 0                  | 20          |                    |                    |                       |
| Dec             | 470                  | 1,680                           | -10                | 20          |                    |                    |                       |
| Total           | 39,420               |                                 | 300                | 5,820       | 440                |                    |                       |
| 1939            |                      |                                 |                    |             |                    |                    |                       |
| Jan             | 900                  | 2,140                           | 0                  | 20          |                    |                    |                       |
| Feb             | 1,000                | 3,020                           | 0                  | 20          |                    |                    |                       |
| Mar             | 1,460                | 4,000                           | 0                  | 20          |                    |                    |                       |
| Apr             | 300                  | 5,440                           | 10                 | 30          |                    |                    |                       |
| May             | 150                  | 5,700                           | 40                 | 40          | 640                |                    |                       |
| June            | 30                   | 5,130                           | 60                 | 60          | 1,560              |                    |                       |
| July            | 0                    | 3,480                           | 70                 | 70          | 1,740              |                    |                       |
| Aug             | 0                    | 1,600                           | 40                 | 70          | 770                |                    |                       |
| Sept            | 0                    | 720                             | 10                 | 50          |                    |                    | -570                  |
| Oct             | 0                    | 660                             | 0                  | 30          |                    |                    | -520                  |
| Nov             | 0                    | 630                             | 0                  | 30          |                    |                    |                       |
| Dec             | 380                  | 600                             | 0                  | 20          |                    |                    |                       |
| Total           | 4,220                |                                 | 230                | 4,710       | 460                |                    |                       |
| 1940            |                      |                                 |                    |             |                    |                    |                       |
| Jan             | 9,500                | 960                             | 0                  | 20          | 3,840              |                    |                       |
| Feb             | 16,000               | 6,600                           | 0                  | 20          | 15,980             |                    |                       |
| Mar             | 7,300                | 6,600                           | 0                  | 20          | 7,280              |                    |                       |
| Apr             | 2,700                | 6,600                           | 10                 | 30          | 2,660              |                    |                       |
| May             | 260                  | 6,600                           | 40                 | 40          |                    |                    |                       |
| June            | 90                   | 6,580                           | 70                 | 60          | 640                |                    |                       |
| July            | 50                   | 5,150                           | 90                 | 80          | 1,560              |                    |                       |
| Aug             | 50                   | 3,340                           | 70                 | 70          | 1,730              |                    |                       |
| Sept            | 30                   | 1,920                           | 40                 | 50          | 1,330              |                    |                       |
| Oct             | 20                   | 1,340                           | 10                 | 40          | 520                |                    |                       |
| Nov             | 230                  | 1,310                           | 0                  | 30          |                    |                    |                       |
| Dec             | 10,500               | 1,510                           | -10                | 20          | 5,400              |                    |                       |
| Total           | 47,380               |                                 | 320                | 5,780       | 480                |                    |                       |
| 1941            |                      |                                 |                    |             |                    |                    |                       |
| Jan             | 12,000               | 6,600                           | 0                  | 20          | 11,980             |                    |                       |
| Feb             | 10,000               | 6,600                           | 0                  | 20          | 9,980              |                    |                       |
| Mar             | 7,100                | 6,600                           | 0                  | 20          | 7,080              |                    |                       |
| Apr             | 7,000                | 6,600                           | 10                 | 30          | 6,960              |                    |                       |
| May             | 1,300                | 6,600                           | 40                 | 40          | 630                |                    |                       |
| June            | 490                  | 6,600                           | 70                 | 70          | 1,550              |                    |                       |
| July            | 230                  | 5,400                           | 90                 | 80          |                    |                    |                       |
| Aug             | 70                   | 3,730                           | 70                 | 80          | 1,730              |                    |                       |
| Sept            | 60                   | 2,330                           | 40                 | 60          | 1,320              |                    |                       |
| Oct             | 60                   | 1,770                           | 10                 | 40          | 520                |                    |                       |
| Nov             | 200                  | 1,780                           | 0                  | 30          |                    |                    |                       |
| Dec             | 9,000                | 1,950                           | -10                | 30          |                    |                    |                       |
| Total           | 47,510               |                                 | 320                | 5,750       | 520                |                    | 4,330                 |

**MONTHLY OPERATION STUDY**  
COLLAYOMI RESERVOIR  
(in acre-feet)

Gross storage: 6,600 acre-feet  
Active storage: 6,000 acre-feet

| : |  |  |  |  |  |  |  |  |  |
|---|--|--|--|--|--|--|--|--|--|
|---|--|--|--|--|--|--|--|--|--|

## APPENDIX G (continued)

MONTHLY OPERATION STUDY  
COLLAYOMI RESERVOIR  
(in acre-feet)

Gross storage: 6,600 acre-feet  
Active storage: 6,000 acre-feet

| Year                             | Unimpaired: Gross storage | Met    | Releases 2/ | Spill or |        |
|----------------------------------|---------------------------|--------|-------------|----------|--------|
| and : inflow : on first of month | month                     | month  | month       | month    |        |
| 1/                               | 1/                        | 1/     | 1/          | 1/       |        |
| month                            | month                     | month  | month       | month    |        |
| 1948                             | 1949                      | 1950   | 1951        | 1952     |        |
| Jan                              | 2,000                     | 1,580  | 0           | 40       | 5,660  |
| Feb                              | 480                       | 3,540  | 0           | 30       | 3,460  |
| Mar                              | 2,500                     | 3,990  | 0           | 40       | 2,650  |
| Apr                              | 6,200                     | 6,450  | 10          | 50       | 5,990  |
| May                              | 1,600                     | 6,600  | 40          | 70       | 880    |
| June                             | 420                       | 6,600  | 70          | 100      |        |
| July                             | 110                       | 5,360  | 90          | 130      |        |
| Aug                              | 40                        | 3,600  | 70          | 120      |        |
| Sept                             | 20                        | 2,180  | 40          | 90       |        |
| Oct                              | 10                        | 1,570  | 10          | 70       |        |
| Nov                              | 10                        | 1,500  | 0           | 50       |        |
| Dec                              | 700                       | 1,460  | -10         | 40       |        |
| Total                            | 14,090                    | 320    | 5,520       | 830      |        |
| 1949                             | 1,350                     | 2,130  | 0           | 40       |        |
| Jan                              | 3,600                     | 3,440  | 0           | 40       | 400    |
| Feb                              | 8,100                     | 6,600  | 0           | 40       | 8,060  |
| Mar                              | 1,200                     | 6,600  | 10          | 50       | 1,140  |
| Apr                              | 420                       | 6,600  | 40          | 70       |        |
| May                              | 100                       | 6,310  | 70          | 110      |        |
| June                             | 40                        | 4,750  | 90          | 130      |        |
| July                             | 20                        | 2,920  | 70          | 130      |        |
| Aug                              | 10                        | 1,480  | 30          | 100      |        |
| Sept                             | 0                         | 860    | 10          | 70       |        |
| Oct                              | 0                         | 780    | 0           | 60       |        |
| Nov                              | 170                       | 720    | 0           | 40       |        |
| Dec                              | 15,010                    | 320    | 5,490       | 880      |        |
| Total                            | 1950                      | 3,800  | 850         | 40       |        |
| Jan                              | 5,800                     | 4,610  | 0           | 40       | 3,770  |
| Feb                              | 2,000                     | 6,600  | 0           | 40       | 1,960  |
| Mar                              | 1,550                     | 6,600  | 10          | 60       | 1,480  |
| Apr                              | 460                       | 6,600  | 40          | 80       |        |
| May                              | 110                       | 6,340  | 70          | 120      |        |
| June                             | 50                        | 4,780  | 90          | 140      |        |
| July                             | 10                        | 2,960  | 70          | 130      |        |
| Aug                              | 10                        | 1,510  | 30          | 100      |        |
| Sept                             | 740                       | 900    | 10          | 80       |        |
| Oct                              | 5,100                     | 1,550  | 0           | 60       |        |
| Nov                              | 8,200                     | 6,590  | -30         | 40       |        |
| Dec                              | 27,830                    | 290    | 5,470       | 930      |        |
| Total                            | 1951                      | 12,300 | 6,600       | 50       | 12,250 |
| Jan                              | 1,200                     | 6,600  | 0           | 40       | 1,160  |
| Feb                              | 3,400                     | 6,600  | 0           | 50       | 3,350  |
| Mar                              | 1,400                     | 6,600  | 10          | 70       | 1,320  |
| Apr                              | 830                       | 6,600  | 40          | 90       | 1,100  |
| May                              | 360                       | 6,600  | 70          | 140      |        |
| June                             | 80                        | 5,290  | 90          | 160      |        |
| July                             | 30                        | 3,500  | 70          | 160      |        |
| Aug                              | 0                         | 2,950  | 40          | 120      |        |
| Sept                             | 0                         | 1,400  | 10          | 90       |        |
| Oct                              | 690                       | 1,300  | 0           | 70       |        |
| Nov                              | 530                       | 1,920  | -10         | 50       |        |
| Dec                              | 20,820                    | 320    | 5,420       | 1,090    |        |
| Total                            | 1952                      | 12,000 | 6,600       | 50       | 11,950 |
| Jan                              | 5,700                     | 6,600  | 0           | 40       | 5,660  |
| Feb                              | 4,400                     | 6,600  | 0           | 50       | 4,350  |
| Mar                              | 1,250                     | 6,600  | 10          | 60       | 1,180  |
| Apr                              | 600                       | 6,600  | 40          | 90       |        |
| May                              | 210                       | 6,470  | 70          | 130      |        |
| June                             | 100                       | 5,020  | 90          | 160      |        |
| July                             | 30                        | 3,240  | 70          | 150      |        |
| Aug                              | 10                        | 1,800  | 40          | 110      |        |
| Sept                             | 0                         | 1,170  | 10          | 80       |        |
| Oct                              | 0                         | 1,080  | 0           | 60       |        |
| Nov                              | 9,000                     | 1,020  | -10         | 50       | 3,380  |
| Dec                              | 33,300                    | 320    | 5,430       | 1,030    |        |
| Total                            | 1953                      | 12,300 | 6,600       | 50       | 12,250 |
| Jan                              | 1,200                     | 6,600  | 0           | 40       | 1,160  |
| Feb                              | 3,400                     | 6,600  | 0           | 50       | 3,350  |
| Mar                              | 1,400                     | 6,600  | 10          | 70       | 1,320  |
| Apr                              | 830                       | 6,600  | 40          | 90       | 1,100  |
| May                              | 360                       | 6,600  | 70          | 140      |        |
| June                             | 80                        | 5,290  | 90          | 160      |        |
| July                             | 30                        | 3,500  | 70          | 160      |        |
| Aug                              | 0                         | 2,950  | 40          | 120      |        |
| Sept                             | 0                         | 1,400  | 10          | 90       |        |
| Oct                              | 690                       | 1,300  | 0           | 70       |        |
| Nov                              | 530                       | 1,920  | -10         | 50       |        |
| Dec                              | 20,820                    | 320    | 5,420       | 1,090    |        |
| Total                            | 1954                      | 12,000 | 6,600       | 50       | 11,950 |
| Jan                              | 5,700                     | 6,600  | 0           | 40       | 5,660  |
| Feb                              | 4,400                     | 6,600  | 0           | 50       | 4,350  |
| Mar                              | 1,250                     | 6,600  | 10          | 60       | 1,180  |
| Apr                              | 600                       | 6,600  | 40          | 90       |        |
| May                              | 210                       | 6,470  | 70          | 130      |        |
| June                             | 100                       | 5,020  | 90          | 160      |        |
| July                             | 30                        | 3,240  | 70          | 150      |        |
| Aug                              | 10                        | 1,800  | 40          | 110      |        |
| Sept                             | 0                         | 1,170  | 10          | 80       |        |
| Oct                              | 0                         | 1,080  | 0           | 60       |        |
| Nov                              | 9,000                     | 1,020  | -10         | 50       | 3,380  |
| Dec                              | 33,300                    | 320    | 5,430       | 1,030    |        |
| Total                            | 1955                      | 12,300 | 6,600       | 50       | 12,250 |
| Jan                              | 1,200                     | 6,600  | 0           | 40       | 1,160  |
| Feb                              | 3,400                     | 6,600  | 0           | 50       | 3,350  |
| Mar                              | 1,400                     | 6,600  | 10          | 70       | 1,320  |
| Apr                              | 830                       | 6,600  | 40          | 90       | 1,100  |
| May                              | 360                       | 6,600  | 70          | 140      |        |
| June                             | 80                        | 5,290  | 90          | 160      |        |
| July                             | 30                        | 3,500  | 70          | 160      |        |
| Aug                              | 0                         | 2,950  | 40          | 120      |        |
| Sept                             | 0                         | 1,400  | 10          | 90       |        |
| Oct                              | 690                       | 1,300  | 0           | 70       |        |
| Nov                              | 530                       | 1,920  | -10         | 50       |        |
| Dec                              | 20,820                    | 320    | 5,420       | 1,090    |        |
| Total                            | 1956                      | 12,000 | 6,600       | 50       | 11,950 |
| Jan                              | 5,700                     | 6,600  | 0           | 40       | 5,660  |
| Feb                              | 4,400                     | 6,600  | 0           | 50       | 4,350  |
| Mar                              | 1,250                     | 6,600  | 10          | 60       | 1,180  |
| Apr                              | 600                       | 6,600  | 40          | 90       |        |
| May                              | 210                       | 6,470  | 70          | 130      |        |
| June                             | 100                       | 5,020  | 90          | 160      |        |
| July                             | 30                        | 3,240  | 70          | 150      |        |
| Aug                              | 10                        | 1,800  | 40          | 110      |        |
| Sept                             | 0                         | 1,170  | 10          | 80       |        |
| Oct                              | 0                         | 1,080  | 0           | 60       |        |
| Nov                              | 9,000                     | 1,020  | -10         | 50       | 3,380  |
| Dec                              | 33,300                    | 320    | 5,430       | 1,030    |        |
| Total                            | 1957                      | 12,300 | 6,600       | 50       | 12,250 |
| Jan                              | 1,200                     | 6,600  | 0           | 40       | 1,160  |
| Feb                              | 3,400                     | 6,600  | 0           | 50       | 3,350  |
| Mar                              | 1,400                     | 6,600  | 10          | 70       | 1,320  |
| Apr                              | 830                       | 6,600  | 40          | 90       | 1,100  |
| May                              | 360                       | 6,600  | 70          | 140      |        |
| June                             | 80                        | 5,290  | 90          | 160      |        |
| July                             | 30                        | 3,500  | 70          | 160      |        |
| Aug                              | 0                         | 2,950  | 40          | 120      |        |
| Sept                             | 0                         | 1,400  | 10          | 90       |        |
| Oct                              | 690                       | 1,300  | 0           | 70       |        |
| Nov                              | 530                       | 1,920  | -10         | 50       |        |
| Dec                              | 20,820                    | 320    | 5,420       | 1,090    |        |
| Total                            | 1958                      | 12,000 | 6,600       | 50       | 11,950 |
| Jan                              | 5,700                     | 6,600  | 0           | 40       | 5,660  |
| Feb                              | 4,400                     | 6,600  | 0           | 50       | 4,350  |
| Mar                              | 1,250                     | 6,600  | 10          | 60       | 1,180  |
| Apr                              | 600                       | 6,600  | 40          | 90       |        |
| May                              | 210                       | 6,470  | 70          | 130      |        |
| June                             | 100                       | 5,020  | 90          | 160      |        |
| July                             | 30                        | 3,240  | 70          | 150      |        |
| Aug                              | 10                        | 1,800  | 40          | 110      |        |
| Sept                             | 0                         | 1,170  | 10          | 80       |        |
| Oct                              | 0                         | 1,080  | 0           | 60       |        |
| Nov                              | 9,000                     | 1,020  | -10         | 50       | 3,380  |
| Dec                              | 33,300                    | 320    | 5,430       | 1,030    |        |
| Total                            | 1959                      | 12,300 | 6,600       | 50       | 12,250 |
| Jan                              | 1,200                     | 6,600  | 0           | 40       | 1,160  |
| Feb                              | 3,400                     | 6,600  | 0           | 50       | 3,350  |
| Mar                              | 1,400                     | 6,600  | 10          | 70       | 1,320  |
| Apr                              | 830                       | 6,600  | 40          | 90       | 1,100  |
| May                              | 360                       | 6,600  | 70          | 140      |        |
| June                             | 80                        | 5,290  | 90          | 160      |        |
| July                             | 30                        | 3,500  | 70          | 160      |        |
| Aug                              | 0                         | 2,950  | 40          | 120      |        |
| Sept                             | 0                         | 1,400  | 10          | 90       |        |
| Oct                              | 690                       | 1,300  | 0           | 70       |        |
| Nov                              | 530                       | 1,920  | -10         | 50       |        |
| Dec                              | 20,820                    | 320    | 5,420       | 1,090    |        |
| Total                            | 1960                      | 12,000 | 6,600       | 50       | 11,950 |
| Jan                              | 5,700                     | 6,600  | 0           | 40       | 5,660  |
| Feb                              | 4,400                     | 6,600  | 0           | 50       | 4,350  |
| Mar                              | 1,250                     | 6,600  | 10          | 60       | 1,180  |
| Apr                              | 600                       | 6,600  | 40          | 90       |        |
| May                              | 210                       | 6,470  | 70          | 130      |        |
| June                             | 100                       | 5,020  | 90          | 160      |        |
| July                             | 30                        | 3,240  | 70          | 150      |        |
| Aug                              | 10                        | 1,800  | 40          | 110      |        |
| Sept                             | 0                         | 1,170  | 10          | 80       |        |
| Oct                              | 0                         | 1,080  | 0           | 60       |        |
| Nov                              | 9,000                     | 1,020  | -10         | 50       | 3,380  |
| Dec                              | 33,300                    | 320    | 5,430       | 1,030    |        |
| Total                            | 1961                      | 12,300 | 6,600       | 50       | 12,250 |
| Jan                              | 1,200                     | 6,600  | 0           | 40       | 1,160  |
| Feb                              | 3,400                     | 6,600  | 0           | 50       | 3,350  |
| Mar                              | 1,400                     | 6,600  | 10          | 70       | 1,320  |
| Apr                              | 830                       | 6,600  | 40          | 90       | 1,100  |
| May                              | 360                       | 6,600  | 70          | 140      |        |
| June                             | 80                        | 5,290  | 90          | 160      |        |
| July                             | 30                        | 3,500  | 70          | 160      |        |
| Aug                              | 0                         | 2,950  | 40          | 120      |        |
| Sept                             | 0                         | 1,400  | 10          | 90       |        |
| Oct                              | 690                       | 1,300  | 0           | 70       |        |
| Nov                              | 530                       | 1,920  | -10         | 50       |        |
| Dec                              | 20,820                    | 320    | 5,420       | 1,090    |        |
| Total                            | 1962                      | 12,000 | 6,600       | 50       | 11,950 |
| Jan                              | 5,700                     | 6,600  | 0           | 40       | 5,660  |
| Feb                              | 4,400                     | 6,600  | 0           | 50       | 4,350  |
| Mar                              | 1,250                     | 6,600  | 10          | 60       | 1,180  |
| Apr                              | 600                       | 6,600  | 40          | 90       |        |
| May                              | 210                       | 6,470  | 70          | 130      |        |
| June                             | 100                       | 5,020  | 90          | 160      |        |
| July                             | 30                        | 3,240  | 70          | 150      |        |
| Aug                              | 10                        | 1,800  | 40          | 110      |        |
| Sept                             | 0                         | 1,170  | 10          | 80       |        |
| Oct                              | 0                         | 1,080  | 0           | 60       |        |
| Nov                              | 9,000                     | 1,020  | -10         | 50       | 3,380  |
| Dec                              | 33,300                    | 320    | 5,430       | 1,030    |        |
| Total                            | 1963                      | 12,300 | 6,600       | 50       | 12,250 |
| Jan                              | 1,200                     | 6,600  | 0           | 40       | 1,160  |
| Feb                              | 3,400                     | 6,600  | 0           | 50       | 3,350  |
| Mar                              | 1,400                     | 6,600  | 10          | 70       | 1,320  |
| Apr                              | 830                       | 6,600  | 40          | 90       | 1,100  |
| May                              | 360                       | 6,600  | 70          | 140      |        |
| June                             | 80                        | 5,290  | 90          | 160      |        |
| July                             | 30                        | 3,500  | 70          | 160      |        |
| Aug                              | 0                         | 2,950  | 40          | 120      |        |
| Sept                             | 0                         | 1,400  | 10          | 90       |        |
| Oct                              | 690                       | 1,300  | 0           | 70       |        |
| Nov                              | 530                       | 1,920  | -10         | 50       |        |
| Dec                              | 20,820                    | 320    | 5,420       | 1,090    |        |
| Total                            | 1964                      | 12,000 | 6,600       | 50       | 11,950 |
| Jan                              | 5,700                     | 6,600  | 0           | 40       | 5,660  |
| Feb                              | 4,400                     | 6,600  | 0           | 50       | 4,350  |
| Mar                              | 1,250                     | 6,600  | 10          | 60       | 1,180  |
| Apr                              | 600                       | 6,600  | 40          | 90       |        |
| May                              | 210                       | 6,470  | 70          | 130      |        |
| June                             | 100                       | 5,020  | 90          | 160      |        |
| July                             | 30                        | 3,240  | 70          | 150      |        |
| Aug                              | 10                        | 1,800  | 40          | 110      |        |
| Sept                             | 0                         | 1,170  | 10          | 80       |        |
| Oct                              | 0                         | 1,080  | 0           | 60       |        |
| Nov                              | 9,000                     | 1,020  | -10         | 50       | 3,380  |
| Dec                              | 33,300                    | 320    | 5,430       | 1,030    |        |
| Total                            | 1965                      | 12,300 | 6,600       | 50       | 12,250 |
| Jan                              | 1,200                     | 6,600  | 0           | 40       | 1,160  |
| Feb                              | 3,400                     | 6,600  | 0           | 50       | 3,350  |
| Mar                              | 1,400                     | 6,600  | 10          | 70       | 1,320  |
| Apr                              | 830                       | 6,600  | 40          | 90       | 1,100  |
| May                              | 360                       | 6,600  | 70          | 140      |        |
| June                             | 80                        | 5,290  | 90          | 160      |        |
| July                             | 30                        | 3,500  | 70          | 160      |        |
| Aug                              | 0                         | 2,950  | 40          | 120      |        |
| Sept                             | 0                         | 1,400  | 10          | 90       |        |
| Oct                              | 690                       | 1,300  | 0           | 70       |        |
| Nov                              | 530                       | 1,920  | -10         | 50       |        |

**MONTHLY OPERATION STUDY**  
**COLLAYOMI RESERVOIR**  
**(in acre-feet)**

Gross storage: 6,600 acre-feet  
 Active storage: 6,000 acre-feet

| Year   | Unimpaired: Gross storage: Met | Releases                 | Spill or |
|--------|--------------------------------|--------------------------|----------|
| month: | 1/ : month                     | 2/ : : Urban : shortages | 3/       |
| 1954   |                                |                          |          |
| Jan    | 6,500                          | 2,410                    | 0        |
| Feb    | 5,200                          | 6,600                    | 0        |
| Mar    | 4,000                          | 6,600                    | 0        |
| Apr    | 3,750                          | 6,600                    | 10       |
| May    | 720                            | 6,600                    | 40       |
| June   | 200                            | 6,580                    | 70       |
| July   | 40                             | 5,100                    | 90       |
| Aug    | 10                             | 3,260                    | 70       |
| Sept   | 0                              | 1,790                    | 40       |
| Oct    | 0                              | 1,130                    | 10       |
| Nov    | 1,100                          | 1,030                    | 0        |
| Dec    | 2,750                          | 2,060                    | -10      |
| Total  | 24,270                         | 320                      | 5,410    |
| 1955   |                                |                          |          |
| Jan    | 1,350                          | 4,770                    | 0        |
| Feb    | 830                            | 6,070                    | 0        |
| Mar    | 850                            | 6,600                    | 0        |
| Apr    | 2,250                          | 6,600                    | 10       |
| May    | 840                            | 6,600                    | 40       |
| June   | 110                            | 6,600                    | 70       |
| July   | 30                             | 5,030                    | 90       |
| Aug    | 0                              | 3,170                    | 70       |
| Sept   | 0                              | 1,680                    | 30       |
| Oct    | 0                              | 1,030                    | 10       |
| Nov    | 0                              | 920                      | 0        |
| Dec    | 15,500                         | 850                      | -10      |
| Total  | 21,760                         | 310                      | 5,400    |

- 1/ From Table 1, "Unimpaired Flow of Dry Creek near Middletown"
- 2/ From Table 8, "Estimated Project Water Demand"
- 3/ Shortages taken on agricultural requirements only.

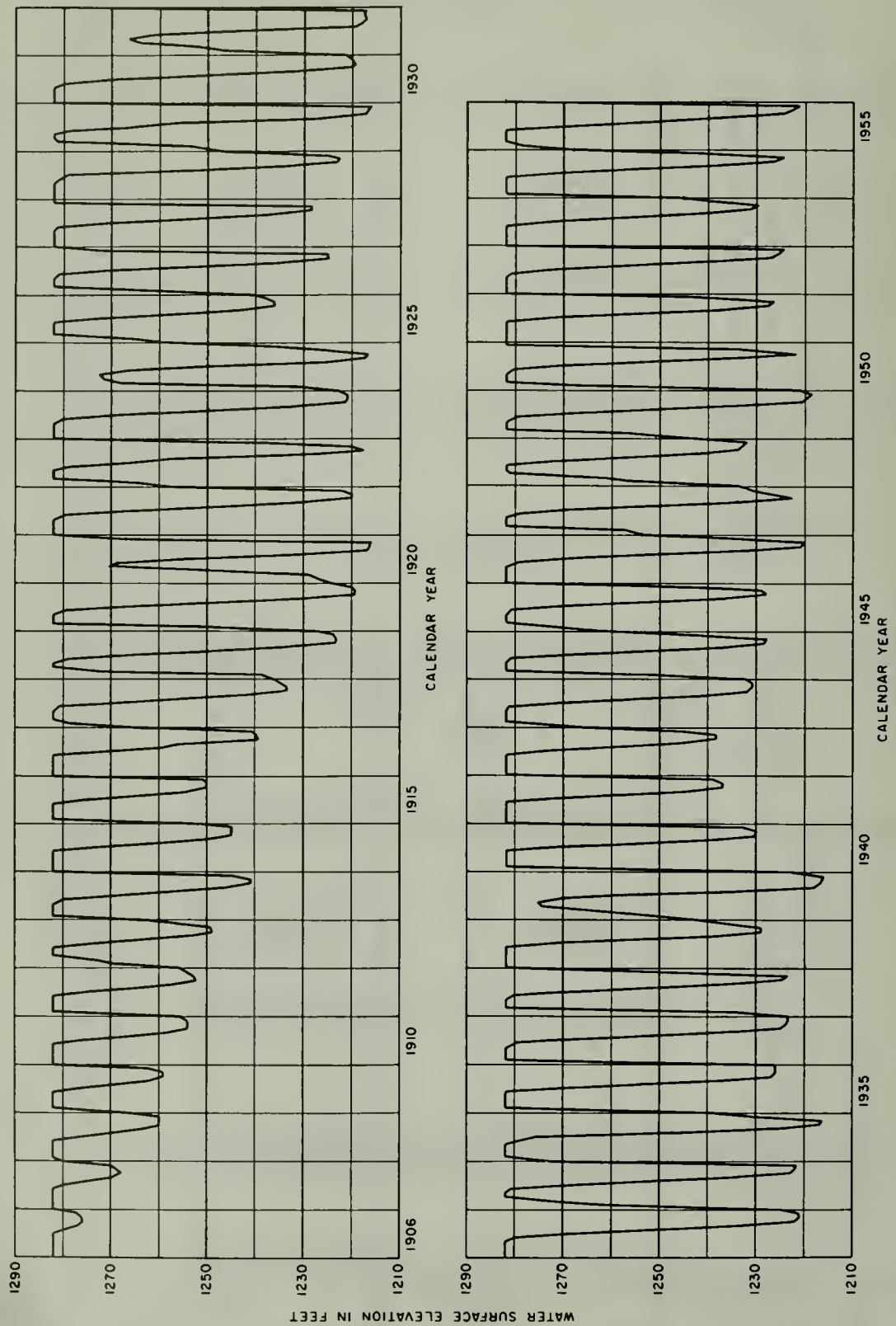


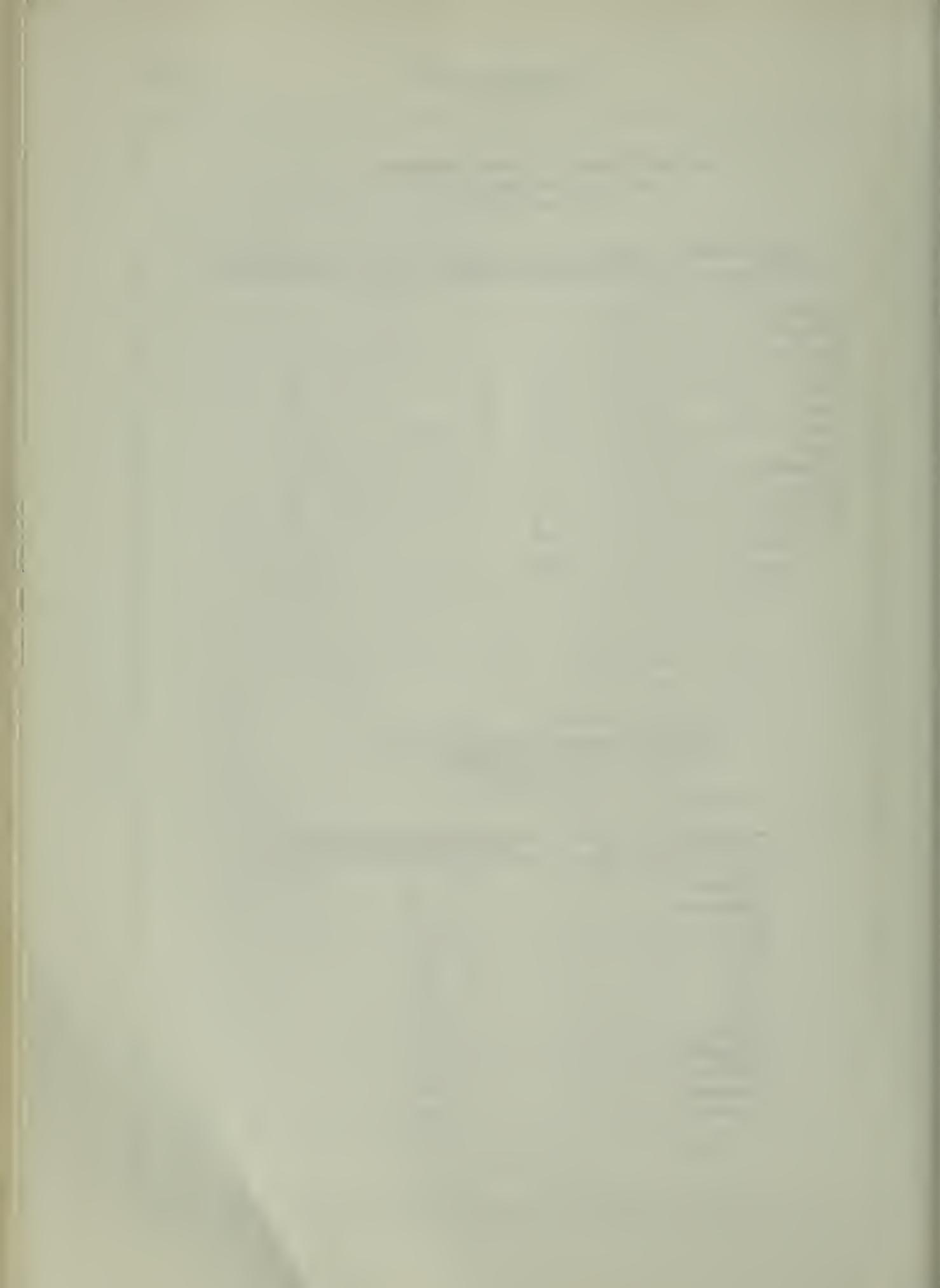
Figure G-1. WATER LEVELS OF COLLAYOMI RESERVOIR

ESTIMATED MONTHLY DEMAND SCHEDULE  
FOR COLLAYOMI RESERVOIR  
(in percent)

| Month     | : | Agricultural demand | : | Urban demand |
|-----------|---|---------------------|---|--------------|
| January   |   | 0                   |   | 5            |
| February  |   | 0                   |   | 4            |
| March     |   | 0                   |   | 5            |
| April     |   | 0                   |   | 6            |
| May       |   | 11                  |   | 8            |
| June      |   | 27                  |   | 13           |
| July      |   | 30                  |   | 15           |
| August    |   | 23                  |   | 14           |
| September |   | 9                   |   | 11           |
| October   |   | 0                   |   | 8            |
| November  |   | 0                   |   | 6            |
| December  |   | 0                   |   | 5            |
| TOTAL     |   | 100                 |   | 100          |

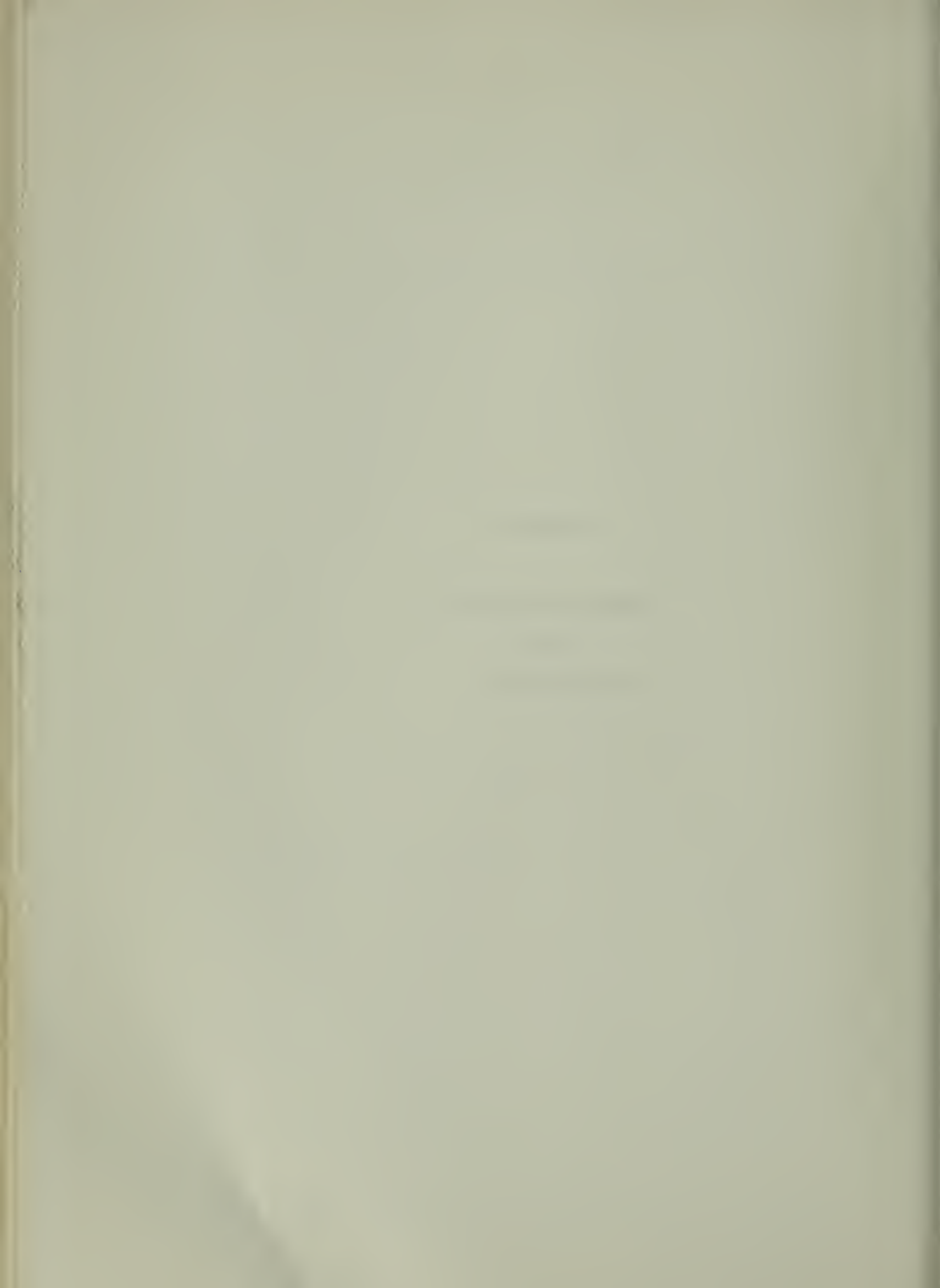
ESTIMATED MONTHLY EVAPORATION RATE  
FOR COLLAYOMI RESERVOIR  
(in feet)

| Month     | : | Net evaporation rate |
|-----------|---|----------------------|
| January   |   | 0                    |
| February  |   | 0                    |
| March     |   | 0                    |
| April     |   | 0.1                  |
| May       |   | 0.3                  |
| June      |   | 0.5                  |
| July      |   | 0.7                  |
| August    |   | 0.7                  |
| September |   | 0.5                  |
| October   |   | 0.2                  |
| November  |   | -0.1                 |
| December  |   | -0.2                 |
| TOTAL     |   | 2.7                  |



APPENDIX H

ESTIMATED CAPITAL COST  
OF THE  
DRY CREEK PROJECT



## ESTIMATED CAPITAL COST OF THE DRY CREEK PROJECT

(Based on prices prevailing in January, 1964)

| Item                          | Unit     | Quantity  | Unit price | Cost          |
|-------------------------------|----------|-----------|------------|---------------|
| <u>Dam and Reservoir</u>      |          |           |            |               |
| <u>Reservoir</u>              |          |           |            |               |
| Rights-of-way                 | ac.      | 177       | 100.00     | \$ 17,700     |
| Clearing                      | ac.      | 111       | 125.00     | 13,900        |
| Buildings                     | lump sum |           |            | 18,000        |
| Road relocation               | lump sum |           |            | <u>96,000</u> |
| Total Reservoir Cost          |          |           |            | \$ 145,600    |
| <u>Dam</u>                    |          |           |            |               |
| Diversion during construction | lump sum |           |            | \$ 10,000     |
| <u>Excavation</u>             |          |           |            |               |
| Foundation stripping          | cu. yd.  | 74,400    | 0.75       | 55,800        |
| Cutoff trench                 | cu. yd.  | 76,000    | 1.50       | 114,000       |
| Borrow area stripping         | cu. yd.  | 10,400    | 1.20       | 12,500        |
| Impervious                    | cu. yd.  | 1,243,000 | 0.39       | 485,000       |
| <u>Embankment</u>             |          |           |            |               |
| Impervious                    | cu. yd.  | 1,118,900 | 0.16       | 179,000       |
| Drain                         | cu. yd.  | 25,600    | 2.00       | 51,200        |
| Rock                          | cu. yd.  | 80,900    | 2.70       | 218,000       |
| Drilling and grouting         | lin. ft. | 7,600     | 9.00       | <u>68,400</u> |
| Total Dam Cost                |          |           |            | \$1,193,900   |
| <u>Spillway</u>               |          |           |            |               |
| <u>Excavation</u>             |          |           |            |               |
| Common                        | cu. yd.  | 120,000   | 0.75       | \$ 90,000     |
| Structural                    | cu. yd.  | 200       | 10.00      | 2,000         |
| Backfill                      | cu. yd.  | 9,700     | 1.30       | 12,600        |
| Blanket, pervious             | cu. yd.  | 650       | 3.00       | 2,000         |
| <u>Concrete</u>               |          |           |            |               |
| Weir                          | cu. yd.  | 230       | 42.00      | 9,700         |
| Floor                         | cu. yd.  | 1,020     | 43.00      | 43,900        |
| Walls                         | cu. yd.  | 1,030     | 68.00      | 70,000        |
| Cement                        | bbl.     | 3,100     | 5.00       | 15,500        |
| Reinforcing steel             | lb.      | 203,100   | 0.15       | 30,500        |
| Miscellaneous items           | lump sum |           |            | <u>11,900</u> |
| Total Spillway Cost           |          |           |            | \$ 288,100    |

## ESTIMATED CAPITAL COST OF THE DRY CREEK PROJECT (cont'd)

(Based on prices prevailing in January, 1964)

| Item                                  | Unit     | Quantity | Unit price | Cost        |
|---------------------------------------|----------|----------|------------|-------------|
| <u>Outlet Works</u>                   |          |          |            |             |
| Excavation                            | cu. yd.  | 8,000    | 1.50       | \$ 12,000   |
| Backfill                              | cu. yd.  | 2,570    | 5.00       | 12,900      |
| Concrete                              |          |          |            |             |
| Intake structure                      | cu. yd.  | 40       | 70.00      | 2,800       |
| Conduit                               | cu. yd.  | 355      | 45.00      | 16,000      |
| Cement                                | bbl.     | 540      | 5.00       | 2,700       |
| Steel                                 |          |          |            |             |
| Reinforcing                           | lb.      | 56,500   | 0.15       | 8,500       |
| Trashrack                             | lb.      | 900      | 0.50       | 500         |
| Pipe                                  | lb.      | 76,000   | 0.40       | 30,400      |
| Slide gate                            | lump sum |          |            | 10,000      |
| Hollow jet valve                      | lump sum |          |            | 8,400       |
| Miscellaneous items                   | lump sum |          |            | 11,100      |
| Total Outlet Works Cost               |          |          |            | \$ 115,300  |
| <u>Other Costs</u>                    |          |          |            |             |
| State dam filing fee                  | lump sum |          |            | \$ 9,400    |
| Total Other Costs                     |          |          |            | \$ 9,400    |
| TOTAL ALL ITEMS                       |          |          |            | \$1,752,300 |
| Contingencies, 20%                    |          |          |            | 350,000     |
| Subtotal                              |          |          |            | \$2,102,300 |
| Engineering and administration, 15%   |          |          |            | 315,000     |
| Subtotal                              |          |          |            | \$2,417,300 |
| Interest during construction @ 3%     |          |          |            | 54,400      |
| TOTAL CAPITAL COST, DAM AND RESERVOIR |          |          |            | \$2,471,700 |

## ESTIMATED CAPITAL COST OF THE DRY CREEK PROJECT (cont'd)

(Based on prices prevailing in January, 1964)

| Item                          | : Unit   | : Quantity | : Unit price | : Cost     |
|-------------------------------|----------|------------|--------------|------------|
| <u>Distribution System</u>    |          |            |              |            |
| <u>Concrete Pressure Pipe</u> |          |            |              |            |
| Permanent easement            | lump sum |            |              | \$ 1,500   |
| Trench excavation             | cu. yd.  | 29,110     | 1.10         | 32,000     |
| Compacted backfill            | cu. yd.  | 2,100      | 1.75         | 3,700      |
| Common backfill               | cu. yd.  | 19,370     | 0.80         | 15,500     |
| Furnish and lay 36" dia.      | lin. ft. | 3,600      | 14.80        | 53,300     |
| Furnish and lay 24" dia.      | lin. ft. | 10,000     | 8.30         | 83,000     |
| Furnish and lay 18" dia.      | lin. ft. | 7,050      | 6.85         | 48,300     |
| Furnish and lay 15" dia.      | lin. ft. | 12,700     | 4.65         | 59,100     |
| Furnish and lay 12" dia.      | lin. ft. | 2,050      | 3.55         | 7,300      |
| Furnish and lay 10" dia.      | lin. ft. | 11,800     | 2.90         | 34,200     |
| Furnish and lay 8" dia.       | lin. ft. | 12,000     | 2.30         | 27,600     |
| Furnish and lay 6" dia.       | lin. ft. | 4,700      | 1.80         | 8,500      |
| Total Pipe Cost               |          |            |              | \$ 374,000 |
| <u>Concrete Lined Canal</u>   |          |            |              |            |
| Rights-of-way                 | ac.      | 74         | 200.00       | \$ 14,800  |
| Clearing                      | ac.      | 74         | 65.00        | 4,800      |
| Excavation                    | cu. yd.  | 55,200     | 0.80         | 44,200     |
| Compacted backfill            | cu. yd.  | 43,500     | 0.40         | 17,400     |
| Concrete lining               | cu. yd.  | 4,530      | 40.00        | 181,200    |
| Re-steel (wire mesh)          | sq. yd.  | 81,700     | 0.10         | 8,200      |
| Fencing                       | lin. ft. | 7,000      | 1.50         | 10,500     |
| Deer crossings                | lump sum |            |              | 500        |
| Joint construction            | lump sum |            |              | 5,000      |
| Cross drainage                | lump sum |            |              | 2,000      |
| Wasteways                     | lump sum |            |              | 3,600      |
| Total Canal Cost              |          |            |              | \$ 292,200 |
| <u>Miscellaneous Items</u>    |          |            |              |            |
| Road crossings                | lump sum |            |              | \$ 25,000  |
| Canal turnouts                | lump sum |            |              | 6,400      |
| Distribution boxes            | lump sum |            |              | 6,800      |
| Standpipes and meters         | lump sum |            |              | 10,000     |
| Gates and valves              | lump sum |            |              | 5,700      |
| Pumps                         | lump sum |            |              | 3,000      |
| Total Miscellaneous Cost      |          |            |              | \$ 56,900  |

## ESTIMATED CAPITAL COST OF THE DRY CREEK PROJECT (cont'd)

(Based on prices prevailing in January, 1964)

| Item                                    | : Unit | : Quantity | : Unit price | : Cost        |
|---|--------|------------|--------------|---------------|
| TOTAL ALL ITEMS                         |        |            |              | \$ 723,100    |
| Contingencies, 10%                      |        |            |              | <u>72,300</u> |
| Subtotal                                |        |            |              | \$ 795,400    |
| Engineering and administration, 10%     |        |            |              | <u>79,500</u> |
| Subtotal                                |        |            |              | \$ 874,900    |
| Interest during construction @ 3%       |        |            |              | <u>13,100</u> |
| TOTAL CAPITAL COST, DISTRIBUTION SYSTEM |        |            |              | \$ 888,000    |
| TOTAL COST OF PROJECT                   |        |            |              | \$3,359,700   |

APPENDIX I

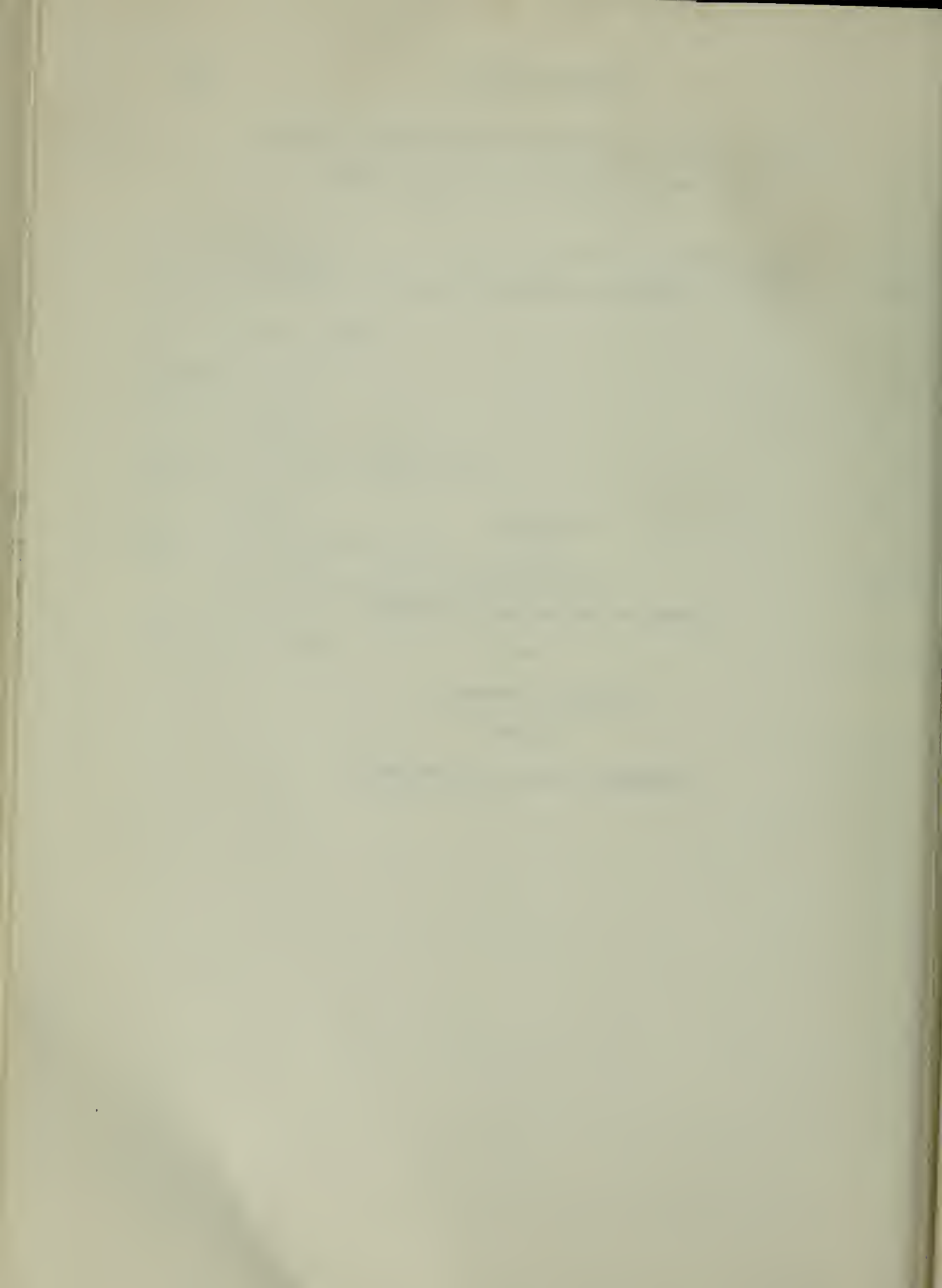
REPORT ON THE RECREATION POTENTIAL

OF

COLLAYOMI RESERVOIR

BY THE

DEPARTMENT OF PARKS AND RECREATION



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# Memorandum

: Honorable William E. Warne COPY  
Director, Department of Water Resources  
1120 "N" Street

Attention Mr. Carl A. Werner  
Chief, Delta Branch

Date : August 27, 1964

Subject: Transmittal of Report-  
Collayomi Reservoir, Lake Co.

: Department of Parks and Recreation

Transmitted herewith are two copies of a report on the recreation potential of Collayomi Reservoir, Lake County. The report is a revised version of the report transmitted to you on April 30, 1964. Revisions were made in conjunction with the staff of the Delta Branch. The report was prepared by our Recreation Contract Services Unit in partial fulfillment of Interagency Agreement 252781. The work was carried out under Work Authority No. 400, Upper Putah Creek Investigation at the request of Mr. Carl A. Werner, Chief, Delta Branch.

The report was prepared with the understanding that the project is not intended to become a part of the State Water Facilities. The investigation which led to the preparation of subject report was coordinated with the Department of Fish and Game.

CHARLES A. DeTURK  
Director

By: /s/ John H. Knight  
JOHN H. KNIGHT  
Deputy Director

Attachment



SUMMARY

Construction of the proposed Collayomi Dam and Reservoir would provide a small recreation lake. Installation of appropriate recreation facilities on all of the 36 acres of suitable land around the lake would accommodate about 60,000 visitor-days per year. After about 10 years, the greater drawdown caused by withdrawals to satisfy increased irrigation and domestic demands would shorten the recreation season and reduce the recreation use to about 50,000 visitor-days per year.

The Department of Fish and Game examined the fishing potential of Collayomi Reservoir and has suggested three alternative schemes of management: (1) warmwater fishery only, (2) warmwater fishery plus early season trout fishery, and (3) warmwater fishery plus extended season trout fishery made possible by controlling the temperature of the water within the reservoir.

Recreation facilities for schemes 1 and 2 would cost about \$550,000. Scheme No. 3 would have an additional cost due to a more elaborate outlet works for releasing water from the reservoir at various elevations.

RECOMMENDATIONS

In order to assure maximum feasible recreation development at the reservoir, it is recommended that the local water agency responsible for the construction and/or operation of the project:

1. Acquire in fee title all lands around the reservoir for a distance of at least 300 feet measured horizontally from the shoreline when the pool is at the spillway lip.
2. Acquire, in addition to the lands in (1) above, the recreation lands shown on Plate I-2, "Collayomi Reservoir Proposed Recreation Development".
3. Acquire the necessary right-of-way and construct a public access road, if feasible, to the public domain lands south and west of the reservoir.

INTRODUCTION

The Legislature in 1962 directed the Department of Water Resources to investigate the feasibility of a water project on Dry Creek near Middletown, Lake County. The project would provide water for irrigation of lands in Collayomi and Long Valleys, assure a domestic water supply for the community of Middletown, and provide an opportunity for the enhancement of recreation, fish, and wildlife resources. Recreation studies of these resources and the features needed for their enhancement proceeded concurrently with engineering studies of the project.

At the time the recreation studies for Bulletin No. 99-1 were formulated, it was not known which of the local agencies would construct and/or operate the project, and to what degree they would be willing to assume responsibility for the operation of the recreation facilities. Therefore, information pertinent to all three schemes of development were included in this report.

PROJECT DESCRIPTION

The proposed Dry Creek Project consists of two main features: (1) a 130-foot high earthfill dam with a gross reservoir storage capacity of 6,600 acre-feet, and (2) a distribution system for transporting the water to the areas of use.

Location

The dam and reservoir would be located on Dry Creek about 2 miles southwest of Middletown, in Sections 4 and 9, T10N, R7W, MDB&M.

Reservoir Surface Area

The proposed reservoir would have a surface area of about 150 acres at spillway crest elevation 1,282 feet. Demands on the reservoir after full development of the service area will cause the reservoir to be drawn down about 55 feet in most years, leaving a surface area of about 60 acres in October. Maximum drawdown will be 66 feet, with a corresponding surface area of 40 acres. It is anticipated that maximum benefits from recreation and fisheries resources would be realized during the first 10 years after the project has been constructed. After this period the increased demands on the reservoir for irrigation and domestic water will accelerate the drawdown and shorten the recreation season.

AREA DESCRIPTIONTopography

The topography in the vicinity of the reservoir is characterized by steep and rugged lands at the higher elevations giving way to gently undulating lands adjacent to the valley floor. The reservoir, located in an arm of Collayomi Valley, has a wide, fairly flat channel section and moderate side slopes. Lands encompassing the reservoir are covered by a mantle of shallow residual soil which supports a heavy growth of brush and scattered timber. Occasional outcrops of rock are visible throughout the area.

Vegetation

The vegetative type dominating the area around the reservoir is classed as chaparral. The shrub species found most frequently are manzanita and chamise. A few knobcone pine and digger pine trees appear to dominate the hill crests. There are a few grassy glades in the chaparral.

Climate

The climate, commonly referred to as Mediterranean, is typical of the region north of San Francisco on the east slope of the Coast Range. It is typified by long, hot dry summers and wet, mild winters. Snow is unusual for the area.

Local Problems

The location of the proposed reservoir is on private land. In the hills just south and west of the reservoir area there are two parcels

of public domain lands, totaling about 4,400 acres, to which there is no public access. The Department of Fish and Game has proposed that a public road be built to provide access to these lands in compensation for deer range lost by construction of the reservoir.

#### Present Land Use

The land in and adjacent to the reservoir area is presently used for cattle range. The cattle forage on annual grass and forbs, but also do some browsing. Two cinnabar mines, now inactive, are situated upstream from the reservoir.

#### Local Economy

The economy of the area is primarily supported by raising beef cattle. Summer resorts and limited lumbering provide additional support to the local economy.

#### PRESENT RECREATION USE

The site of the proposed dam and reservoir is posted against trespassing, and is all in one ownership. Deer and upland game are prevalent in the area. Dry Creek is intermittent in its lower reaches during the summer and fall seasons, which limits opportunities for fishing. The brush cover and general topography discourage hiking and associated recreation activities. It is doubtful that more than 500 visitor-days of recreation use annually are realized within the reservoir area.

FUTURE RECREATION USE

Projection of future recreation use at the proposed Collayomi Reservoir was based on the assumption that recreation will occur in a pattern similar to that at a comparable existing reservoir. Lake Hennessey in Napa County was selected as being the most closely comparable. Because of the very small amount of land suitable for recreation use and development around the Collayomi Reservoir, and because of the large recreation demand, it has been assumed that any facilities to be installed would be for the highest possible density of use, which is day use. Overnight and vacation recreation development have been excluded.

Per Capita Demand

It was determined from the population within a 40-mile radius of Lake Hennessey that the per capita demand for recreation use at the time of the 1960 census was 0.5 visitor-days. The figure 0.5 visitor-days per capita was used to calculate the recreation demand for the Collayomi Reservoir originating within the day-use service area at the initial year after construction. Recreation demand during later years was projected by adding to the initial demand (0.5) the amount of expected increase, estimated to be 0.137 visitor-days per decade.

The area shown on Plate I-1, "Area of Visitor Origin for Recreation Use", will encompass an almost oval area extending from the south end of Clear Lake to Vallejo, and west from Napa Valley to Sonoma Valley. Population projections for this area were prepared by the Department of Water Resources for the decades 1970 to 2020, and were used in calculations of the recreation demand for the proposed reservoir.

Projected recreation demand in visitor-days to the year 2020 is shown below:

| <u>Decade</u> | <u>Visitor-Days</u> |
|---------------|---------------------|
| 1970          | 214,000             |
| 1980          | 474,000             |
| 1990          | 802,000             |
| 2000          | 1,226,000           |
| 2010          | 1,726,000           |
| 2020          | 2,478,000           |

A recent estimate prepared by the U. S. Forest Service, California Region, indicated that on Forest Service lands, about one-half of the hunters using those lands can also be expected to go fishing. This additional fishing demand is not included in the preceding table.

#### Land Capacity

The land suitable for recreation development near the perimeter of the reservoir was found to be 36 acres. The daily land capacity would be 820 visitor-days if all suitable recreation land were developed.

#### Recreation Season

The recreation season would begin about April 1 and extend through September, a total of about 180 days. Operation studies of the proposed reservoir indicate that early in the life of the project, draw-down would start in May and continue until September or October. Significant reduction of the reservoir surface area would occur early in June and continue so that the recreation development area would be at some distance from the reservoir waterline early in July. Later in the life of the project, drawdown would begin earlier in the season and be more severe.

The reduced surface area of the reservoir would have two detrimental effects upon recreation use. The first and least significant effect would be the impairment of the esthetic values of the reservoir. The second, and highly significant effect, would be to place the water surface within a distance of 1,000 feet of the outlet. This distance is considered critical at domestic water supply reservoirs by Public Health authorities, and within that radius all recreation is prohibited.

The result of the accelerated drawdown would be to shorten the recreation season from 180 days to about 150 days annually.

The major attraction and probably the major recreation use of the proposed Collayomi Reservoir would be fishing. The Department of Fish and Game examined the fishing potential and has suggested three alternative schemes of fishery management: (1) warmwater fishery only, (2) warmwater fishery plus early season trout fishery, and (3) warmwater fishery plus extended season trout fishery made possible by controlling the water temperature in the reservoir through the installation of a variable stage outlet tower or similar device.

The warmwater fishery would be the least expensive to maintain, but would afford the least recreation potential because of competition with nearby Clear Lake and Lake Berryessa.

A warmwater fishery combined with a trout fishery would be more attractive and produce more visitor-days of angling than a warmwater fishery alone.

Provisions for controlling the water temperature within the reservoir would permit a trout fishery season to be extended into the summer and provide the greatest recreation use.

The projected annual recreation use under the three alternative fishery management schemes, including the effect of accelerated drawdown, is listed by decades in number of visitor-days in Table I-1.

TABLE I-1

## Projected Annual Recreation Use in Visitor-Days

| <u>Decade</u> | <u>Warmwater<br/>fishery<br/>only</u> | <u>Combined warmwater<br/>fishery &amp; trout</u> | <u>Warmwater fishery<br/>with trout fishery<br/>and variable stage<br/>outlet tower</u> |
|---------------|---------------------------------------|---|---|
| 1970          | 40,000                                | 60,000  | 65,000  |
| 1980          | 30,000                                | 50,000  | 55,000  |
| 1990          | 30,000                                | 50,000  | 55,000  |
| 2000          | 30,000                                | 50,000  | 55,000  |
| 2010          | 30,000                                | 50,000  | 55,000  |
| 2020          | 30,000                                | 50,000  | 55,000  |

Land Use and Acquisition Plan

As part of the evaluation of the recreation resource at the proposed Collayomi Reservoir, the location, quantity, proper use, and recreation capacity of all lands in the immediate vicinity of the reservoir were studied. Good recreation land is scarce, and is particularly scarce adjacent to the reservoir.

A land use plan, showing five picnic areas, a concession area, and the location of a reservoir overlook is delineated on Plate I-2. The acquisition line as shown includes sufficient lands for natural areas and to protect the esthetic character of the site from encroachment.

Two of the picnic areas would be accessible by boat only because road construction to them would be excessively expensive when compared to their expected use. A boat-launching ramp could be installed as part of the development for the concession area.

Data on the proposed development sites are summarized as follows:

Total developable area at reservoir: 36 acres.

| <u>Type of development</u> | <u>Area in<br/>acres</u> | <u>Daily capacity in<br/>visitor-days</u> |
|----------------------------|--------------------------|---|
| Overlook                   | 1                        |   |
| Parking area               | 5                        |   |
| Picnic area                | <u>30</u>                | <u>          </u>                         |
| TOTAL                      | 36                       | 820                                       |

The largest of the proposed development sites is about 16 acres. Since it does not have access, it will be necessary to construct a road to the area. The existing county roads within the area affected by the proposed reservoir must be relocated to provide access for the resident property owners. Possible routes around the reservoir on the north and south side were found to be about equal in cost. Access to the recreation area would require the road to be routed along the south shore of the reservoir. Inasmuch as costs are about equal by either route, it was assumed that the road would be located along the south shore.

The costs for developing the proposed onshore recreation facilities for Collayomi Reservoir are presented in Table I-2.

TABLE I-2

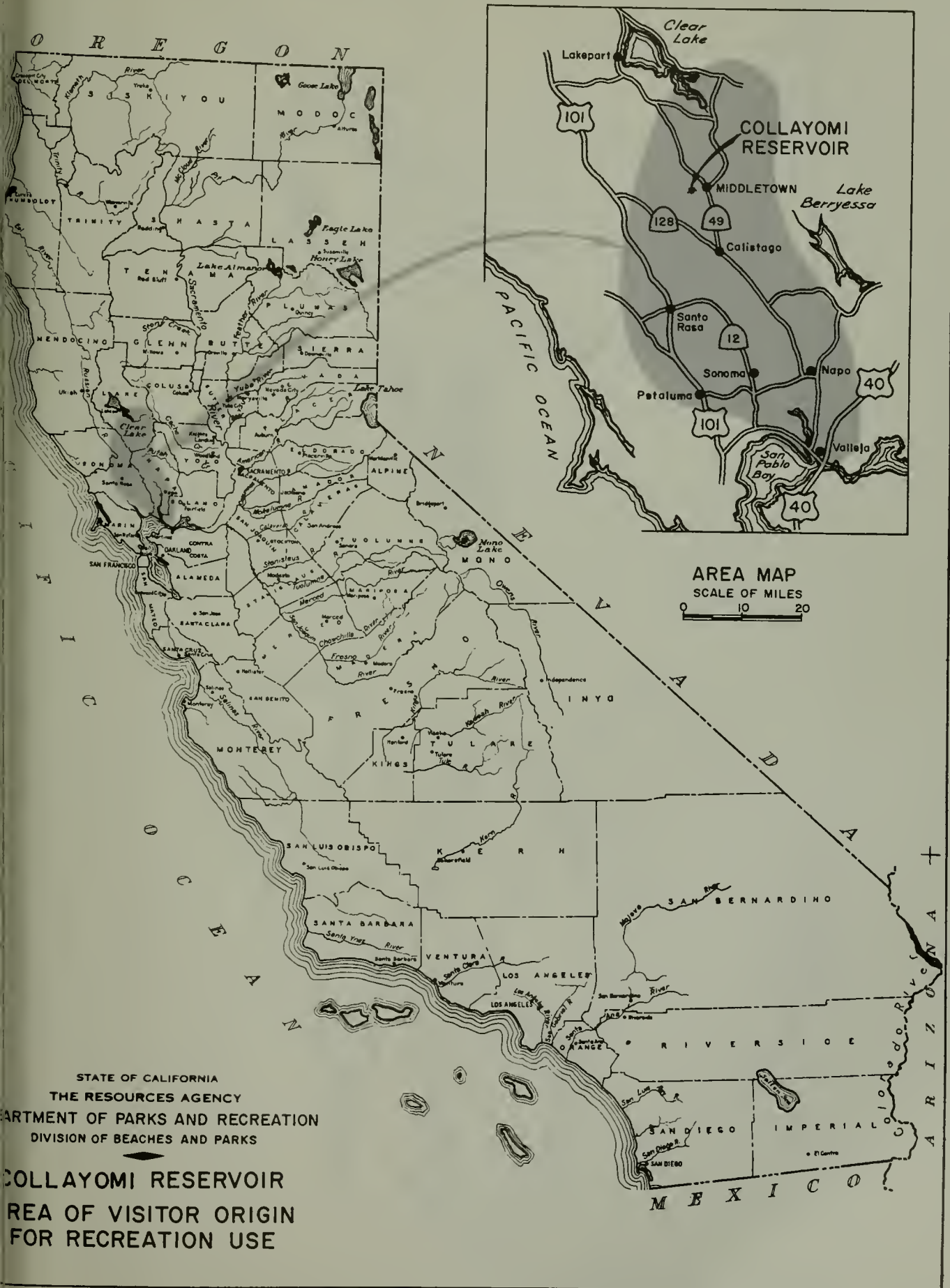
Estimated Cost of Onshore Recreation Facilities  
for  
Collayomi Reservoir

| <u>Items</u>        | <u>Cost per unit</u> | <u>Subtotal</u> |
|---------------------|----------------------|-----------------|
| Land acquisition    |                      | \$ 26,000       |
| Picnic units        | \$2,750              |                 |
| 130 (road access)   |                      | 357,500         |
| 25 (boat access)    |                      | 68,750          |
| Overlook            |                      | 5,000           |
| Beach               |                      | 5,000           |
| Water supply system |                      | <u>85,000</u>   |
| TOTAL               |                      | \$547,250       |

On Plate I-2 is illustrated a 100-unit picnic area with parking which could be developed on the largest of the five developable units.

OPERATION OF RECREATION AREA

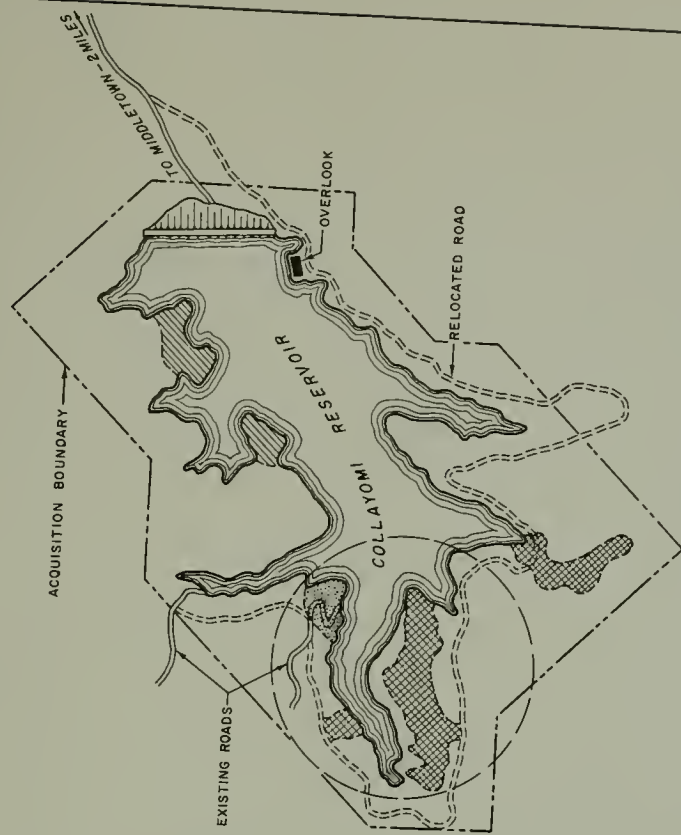
It was assumed that the proposed water project would be owned and operated by a responsible local water agency, and that the agency would also provide for the operation of the recreation facilities at the reservoir.







INITIAL RECREATION DEVELOPMENT PROPOSAL



LAND USE AND ACQUISITION PROPOSAL

- LEGEND
- PICNIC AREA
  - PICNIC AREA—BOAT ACCESS ONLY
  - CONCESSION AREA

STATE OF CALIFORNIA  
THE RESOURCES AGENCY  
DEPARTMENT OF PARKS AND RECREATION  
DIVISION OF BEACHES AND PARKS

COLLAYOMI RESERVOIR  
PROPOSED RECREATION DEVELOPMENT



APPENDIX J

COMMENTS AND RECOMMENDATIONS

ON THE

DRY CREEK PROJECT

BY THE

DEPARTMENT OF FISH AND GAME



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| Fishery With the Project . . . . .     | J-3         |
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| <u>Plate No.</u> | <u>Title</u>  |     |
|------------------|---|-----|
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COPY

State of California

The Resources Agency

## MEMORANDUM

TO: Honorable William E. Warne, Director  
Department of Water Resources  
P. O. Box 388  
Sacramento, California

DATE: April 23, 1964

FROM: Department of Fish and Game, 722 Capitol Mall, Sacramento, California

SUBJECT: WP - State of California, Department of Water Resources, Upper Putah Creek Investigation - Comments and Recommendations of the Department of Fish and Game on Dry Creek Reservoir Project, Dry Creek, Lake County.

The Department of Fish and Game, through its Contract Services Section, has conducted a limited investigation of the impact of the proposed Dry Creek Reservoir Project on the fish and wildlife resources of the project area. Funds for this work in the amount of \$2,000 were provided during the current fiscal year by the Delta Branch, Department of Water Resources.

It is our understanding that the project will most likely be constructed by the Lake County Flood Control and Water Conservation District with funds obtained under the terms of the Watershed Protection and Flood Prevention Act (Public Law 566). We also understand that the district may request Davis-Grunsky Act funds to construct necessary fish, wildlife and recreation facilities.

We have made those fish and wildlife studies possible within the time and budgetary limitations prevailing and have developed recommendations which will assist the constructing agency in protecting existing resources and in maximizing the fish and wildlife enhancement opportunities attendant to the project.

## RECOMMENDATIONS

In order to assure the maximum development of fish and wildlife and associated use thereof at the proposed Dry Creek Reservoir Project, it is recommended that the constructing agency accomplish the following:

- (1) Provide those on-shore recreation facilities proposed by the Department of Parks and Recreation in its report, "Recreation Studies, Dry Creek Project, Lake County", dated January 1964.

Honorable William E. Warne

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April 23, 1964

- (2) Investigate the potential of a multiple-level or variable-stage intake structure at Collayomi Dam to maintain in Collayomi Reservoir water of suitable quality to support a trout fishery throughout the summer.
- (3) Provide fencing of suitable quality to prevent the entry of juvenile deer into those sections of the proposed Dry Creek Canal in which they would likely be lost by drowning. (The department has determined that the initial canal reach, i.e., that section lying between Dry Creek and the first concrete pipe lateral, would require fencing. Recommendations for additional fencing, if later determined necessary, will be made in advance of final canal design.)
- (4) Cooperate with the United States Department of the Interior in the acquisition of such lands or easements as may be required to ensure public access to those parcels of public domain which lie at the head of the Dry Creek drainage and which are shown on the map attached to this memorandum. 1/

Following is a discussion of our findings and conclusions regarding existing fish and wildlife in the project area and the probable effect of the proposed dam, reservoir, and canal on these resources.

#### Fishery Without the Project

Rainbow trout are found in Dry Creek as far upstream as the Wall Street Mine, approximately three miles above the damsite. Samples taken on January 9, 1964, indicate an average trout density of 211 harvestable fish per stream mile in and below the project site. This reach could, therefore, support an estimated 312 angler-days of fishing effort annually under present conditions.

Nongame species also sampled, listed in descending order of abundance, were Sacramento squawfish, western roach, and riffle sculpins.

#### Wildlife Without the Project

Game species in the project area include black-tailed deer, valley and mountain quail, and gray squirrels. Pellet group counts made in 1963 indicate that the deer population in the drainage area averages 81 animals per square mile, or 19 deer in the reservoir site. Recent land ownership changes have

1/ A specific access proposal is found in the section "Wildlife With the Project."

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April 23, 1964

eliminated public deer hunting opportunities in the area. Prior to these changes, however, an estimated 195 hunter-days of annual use occurred in the Dry Creek drainage.

Strip samples indicate a population of 112 valley quail in the reservoir site. Mountain quail are known to be present in the site, however none were observed during the 1963 survey. Quail hunting pressure in the reservoir area is light.

Gray squirrels are common in the reservoir area; however, as in the case of quail, their use by hunters is relatively light.

### Fishery With the Project

The trout fishery below the proposed Collayomi Dam will be lost since the water required for its maintenance can be put to better use in the development of a fishery in the proposed reservoir. This loss, as indicated previously, represents a potential total of 312 angler-days per annum. The effect of the impairment of Dry Creek flows, as indicated in Water Resources' project operation study V-I, does not pose a threat to gamefish production in Putah Creek.

There is little doubt that the proposed reservoir could support a satisfactory population of warmwater gamefish. The moderate drawdown indicated in study V-I during the April-June period would provide adequate spawning conditions for warmwater species. The chemical analysis of Dry Creek water indicates a slightly alkaline quality, well suited to biological productivity in the proposed reservoir.

The potential of Collayomi Reservoir to support a trout fishery was investigated. The key to the development of such a fishery appears to be midsummer water quality. A single, low-level outlet in the dam, as currently proposed by Water Resources, would tend to withdraw cool water from the lake quite early in the summer. We have estimated that temperature and oxygen conditions under this scheme would become unsuitable for trout by late June of most years. Such an operation would limit trout management to the stocking of catchable-sized fish during May and June. Maintenance of satisfactory angling under such a program would involve a planting cost of \$10,000 annually and would provide an estimated 10,000 angler-days of fishing. 1/

If suitable water temperatures could be maintained throughout the summer by the use of a multiple-level of variable-stage intake, a more economical trout fishery could be provided. Under such conditions subcatchable-sized trout could be stocked in the lake in the fall and could utilize natural foods to attain harvestable size by the following spring and summer. Such a fishery could support an estimated 18,500 angler-days of use at an annual planting cost of \$6,500. 2/

1/ Assume an average of 3.5 hours per angler-day, catch rate of 1.0 fish per angler-hour, and a return of 70 percent of the fish to the creel.

2/ Assume an average of 3.5 hours per angler-day, catch rate of 0.5 fish per angler-hour, and a return of 50 percent of the fish to the creel.

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April 23, 1964

The following table summarizes the possible fishery alternatives, their respective costs and use levels:

| <u>Fishing<br/>Alternative</u>   | <u>Estimated Annual<br/>Planting Cost</u> | <u>Estimated Annual<br/>Angler Use</u> |
|--|---|--|
| 1. Warmwater<br>(standard intake)                                      | \$ 0                                      | 3,000 days                             |
| 2. Warmwater and trout<br>(standard intake)                            | 10,000                                    | 13,000                                 |
| 3. Warmwater and trout<br>(multiple-level or<br>variable-stage intake) | 6,500                                     | 23,000                                 |

#### Wildlife With the Project

One feature of the Dry Creek Project is a water conveyance system which rings most of the Collayomi Valley and much of Long Valley at approximate elevation 1,200. Nearly 80,000 feet of this system will consist of an open, concrete-lined canal. The canal will bisect the deer range in this area by separating the shelter of the wooded slopes above elevation 1,200 from the open grazing lands which lie below the proposed canal alignment. While the size of the structure does not pose a threat to adult deer, the department is concerned about the possible loss of fawns in the canal.

Water depth in much of the canal will be two feet; velocities will vary between 1.0 and 4.4 feet per second. Fawns are dropped in late spring and early summer when canal deliveries will be heavy. Fawns are less than two feet high at the time of their birth. The Department of Fish and Game does not have precise knowledge at the present time to indicate which canal sections will be dangerous to fawns and which will not. Suffice to say, however, that the initial section, extending from the dam to the first concrete pipe lateral and intended to carry the entire project release at velocities up to 4.4 feet per second, will be dangerous to fawns and should be enclosed with suitable fencing. Experimental work on the swimming and climbing ability of fawns has been scheduled by the department for summer 1964. Results of these studies will indicate whether additional fencing will be required before the Dry Creek Canal design is finalized.

As indicated earlier, it is estimated that 19 deer will be lost as a result of the construction of the proposed reservoir. Of much greater significance to hunters, however, has been the recent prohibition of public access across private lands to scattered parcels of public domain which lie at the head of the Dry Creek drainage. The attached map illustrates how these public lands, containing over 4,400 acres, are isolated from use by their legal owners, the public.

Honorable William E. Warne

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April 23, 1964

One such parcel, containing 1,820 acres, lies immediately south and west of the reservoir site. The proposed relocation of Dry Creek Road around the head of the lake will bring recreationists to within 100 yards of the public land at the point where the new road will cross the south fork of Dry Creek.

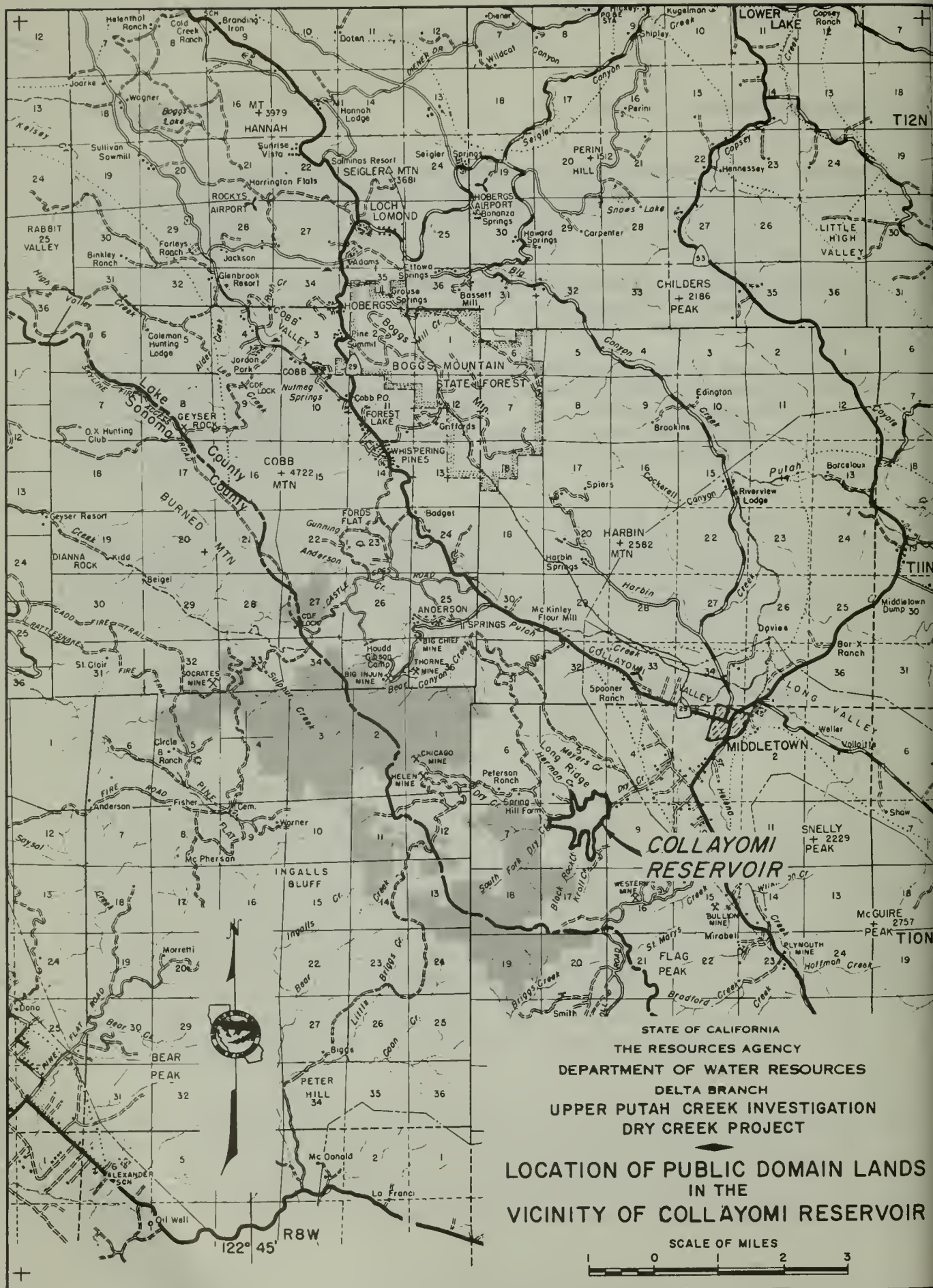
A second parcel, containing 2,240 acres, lies two miles beyond the end of the proposed project road. Use by the public of the existing road is prohibited by the present landowner.

The Department of Fish and Game proposes that the agency which develops the Dry Creek Reservoir Project compensate for the aforementioned wildlife losses by providing public access to the public domain described above. The Ukiah District staff of the Bureau of Land Management has indicated that it would welcome this opportunity to initiate wildlife enhancement programs on these lands.

Public access to the vicinity of Research Mine should be provided via the existing Dry Creek Road; access should be acquired to the southern parcel from the Ida Clayton Road along the Lake-Sonoma county line. Total length of these rights-of-way would approximate 2.7 miles; minimum width should not be less than 60 feet. These rights-of-way are to be considered project costs.

/s/ W. T. Shannon  
Director

Attachment



APPENDIX K

General Description  
of the  
Watershed Protection and Flood Prevention Act



### Introduction

The economic and financial analyses of the Dry Creek Project were prepared in accordance with requirements for financing under the Watershed Protection and Flood Prevention Act, Public Law 83-566, as amended. A brief description of this program follows. Additional information can be obtained from the State Division of Soil Conservation or the U. S. Soil Conservation Service.

### Watershed Protection and Flood Prevention Act

Public Law 83-566, as amended, authorizes the United States Secretary of Agriculture, through the Soil Conservation Service, to cooperate with local agencies in the planning and construction of works for improving, protecting, and developing the land and water resources of small upstream watershed areas or subwatershed areas. Under this act the Federal Government is authorized to pay 100 percent of certain project costs and to share certain others with the local sponsors. In addition, the Federal Government is authorized to provide low interest rate loans administered by the Farmers Home Administration to financially assist sponsoring groups with their share of the project costs.

To be eligible for federal assistance, a project must have one or more of the following purposes: flood prevention, agricultural water development or utilization, or agricultural drainage. Additional purposes may include municipal and industrial water development, fish and wildlife development, recreation, and pollution abatement.

The watershed area for any project must not exceed 250,000 acres. The storage capacity of any reservoir is limited to not more than 5,000

acre-feet for flood water detention and not more than 25,000 acre-feet for all project purposes. Although the act does not specify any limitation for total cost, the U. S. Bureau of the Budget is understood to have imposed a ceiling of \$5 million federal dollars per individual project.

In order to qualify, a project must contain both land treatment and structural measures. This is one of the distinctive features that separates this program from other federal programs. Structural measures include features such as dams and water distribution facilities. Land treatment includes the on-farm conservation measures that soil conservation districts normally handle, fire protection, and stabilization of critical erosion areas beyond the abilities of the owners.

The Federal Government pays about one-half the construction cost of irrigation features and the total cost of installation services on these features. Under certain conditions, the Federal Government also shares in the cost of recreation and fish and wildlife development and bears a portion of the costs of fire protection and soil stabilization. The cost of technical assistance to accelerate land treatment measures is entirely borne by the Federal Government. Agricultural Conservation Program payments may be received on land treatment measures the same as without the project. All federal costs are nonreimbursable.

All structural costs associated with municipal and industrial water development must be borne by the local water users. It is also necessary that the sponsoring local organizations acquire the lands, easements, and rights-of-way for the projects and relocate utilities at their own expense. The local sponsors must also install and pay the cost

of on-farm land treatment measures. All works of improvement installed as part of the project which require operation must be operated and maintained at non-federal expense so that they will continue to function as designed for 50 years or longer.

Eligibility requirements set forth by the Secretary of Agriculture specify that the local interests must be legally empowered to install, maintain, and operate the works of improvement; be able to repay the loan; and have the legal capacity for obtaining, giving security and raising revenues for repayment of the loan. The sponsors must also provide assurance that they or the individuals concerned have or can obtain the necessary legal water rights.

The interest rate on loans obtained through the Farmers Home Administration is governed by the average rate paid on the outstanding long-term marketable securities of the United States Treasury. The rate announced at the beginning of a fiscal year will prevail throughout that fiscal year. During 1964 the interest rate was 3 percent. Loans are scheduled for repayment within the shortest practical time consistent with the ability of the borrower to repay. The repayment period may not exceed 50 years or the useful life of the facility, whichever is less. The repayment year begins when the principal benefits begin to accrue to the project.

#### Procedures for Implementing Projects

Briefly, the following steps must be accomplished prior to project construction.

- A. The sponsors ask the State Division of Soil Conservation for a field review of the project.
- B. Representatives of the State Division of Soil Conservation and the Federal Soil Conservation Service review the proposal with the sponsors to see whether the project fits into the Public Law 83-566 framework.

Discussions with personnel in the State Division of Soil Conservation indicate that the foregoing requirements have been accomplished for the Dry Creek Project. The proposed project is one which could be built under Public Law 83-566.

- C. The sponsors write to the State Division of Soil Conservation to request a reconnaissance survey of the project.
- D. A reconnaissance survey is made by the State Division of Soil Conservation.

Discussions with personnel of the State Division of Soil Conservation indicate that this report should suffice as the necessary reconnaissance survey.

- E. If the reconnaissance survey shows that the project has a reasonable chance of justification, the sponsors prepare and submit an application for assistance.
- F. The State Soil Conservation Commission approves the application if it meets with their criteria.
- G. It is the primary responsibility of the sponsors to prepare a work plan. When the Federal Soil Conservation Service or the State Division of Soil Conservation has planning facilities available, personnel are assigned to assist the sponsors in preparing the work plan.
- H. Normally, the sponsors form a Steering Committee to meet with the planning technicians to advise them on the local desires.

- I. The planning party acquires more detailed data than in the reconnaissance planning phase, makes analyses of various combinations of measures to accomplish the project objectives, and formulates the project in consultation with the Steering Committee.
- J. At the time the project is in the tentative stage, the Steering Committee should hold hearings with small localized groups to learn whether the proposal actually has broad support and to evaluate any opposition that may arise.
- K. The planning party prepares a "policy draft" of the Watershed Work Plan for review by the Administrator's office and the Engineering and Watershed Planning Unit in Portland, Oregon.
- L. On approval of the "policy draft", a "review draft" is prepared and reproduced in quantity. Copies go to all interested State and Federal agencies within California.
- M. Necessary adjustments are made and a final draft of the work plan is prepared. At this time, the sponsors sign the Watershed Work Plan Agreement. If the Federal contribution to the construction cost is less than \$250,000, the State Conservationist approves the plan. Otherwise, the final draft undergoes the following:
  - (1) - Thirty-day review by the Secretary of the Interior or the Secretary of the Army.
  - (2) - Review by the Governor.
  - (3) - Review by the office of the Secretary of Agriculture.
  - (4) - Review by the Bureau of the Budget.
  - (5) - Review and approval by the appropriate committees of the U. S. Senate and the House of Representatives.
- N. The Administrator authorizes construction.



APPENDIX L

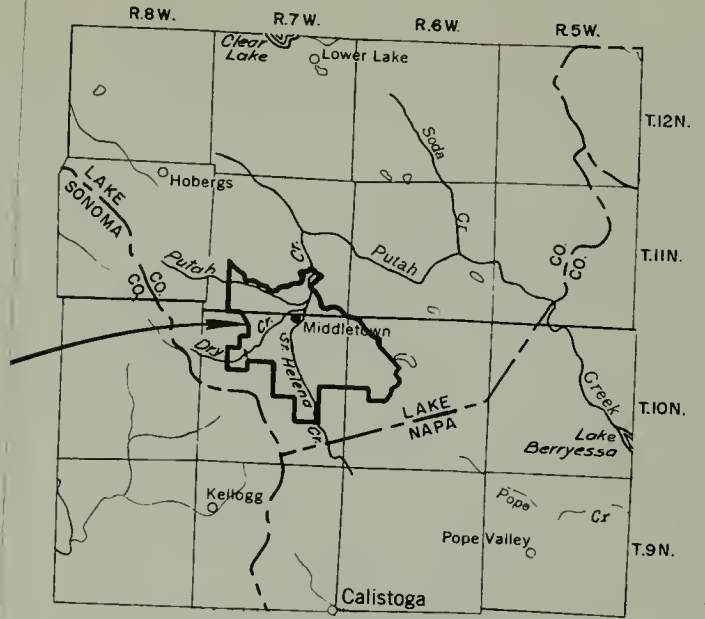
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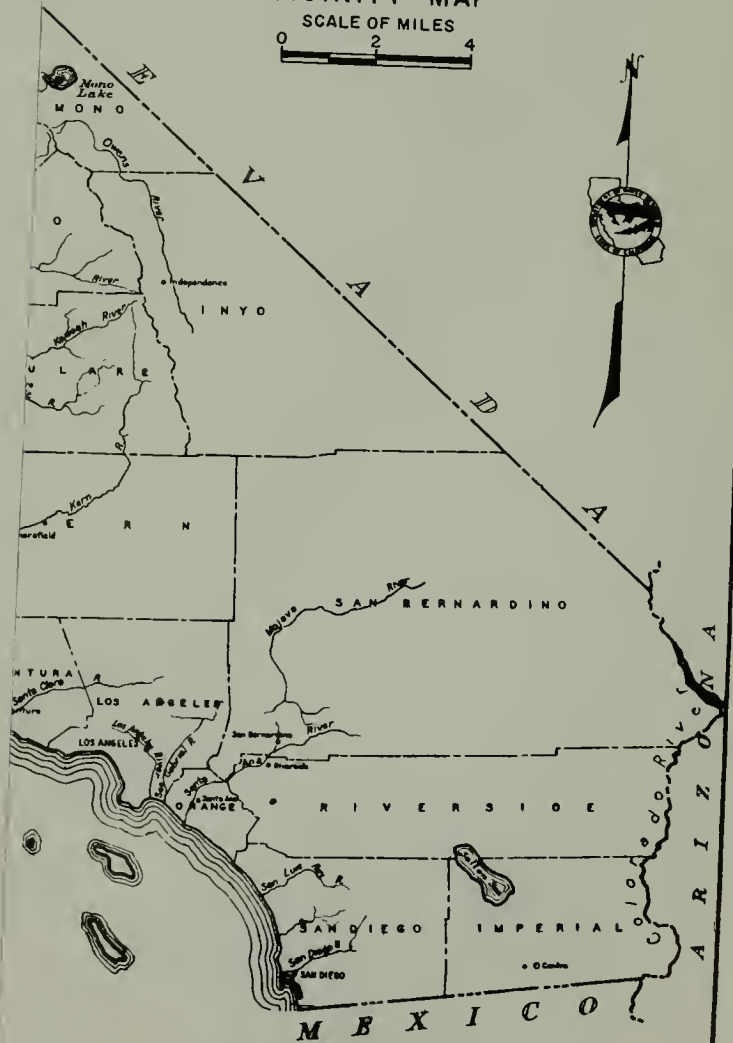
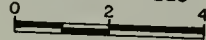
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5. Upson, J. E. and Kunkel, F., "Ground Water of the  
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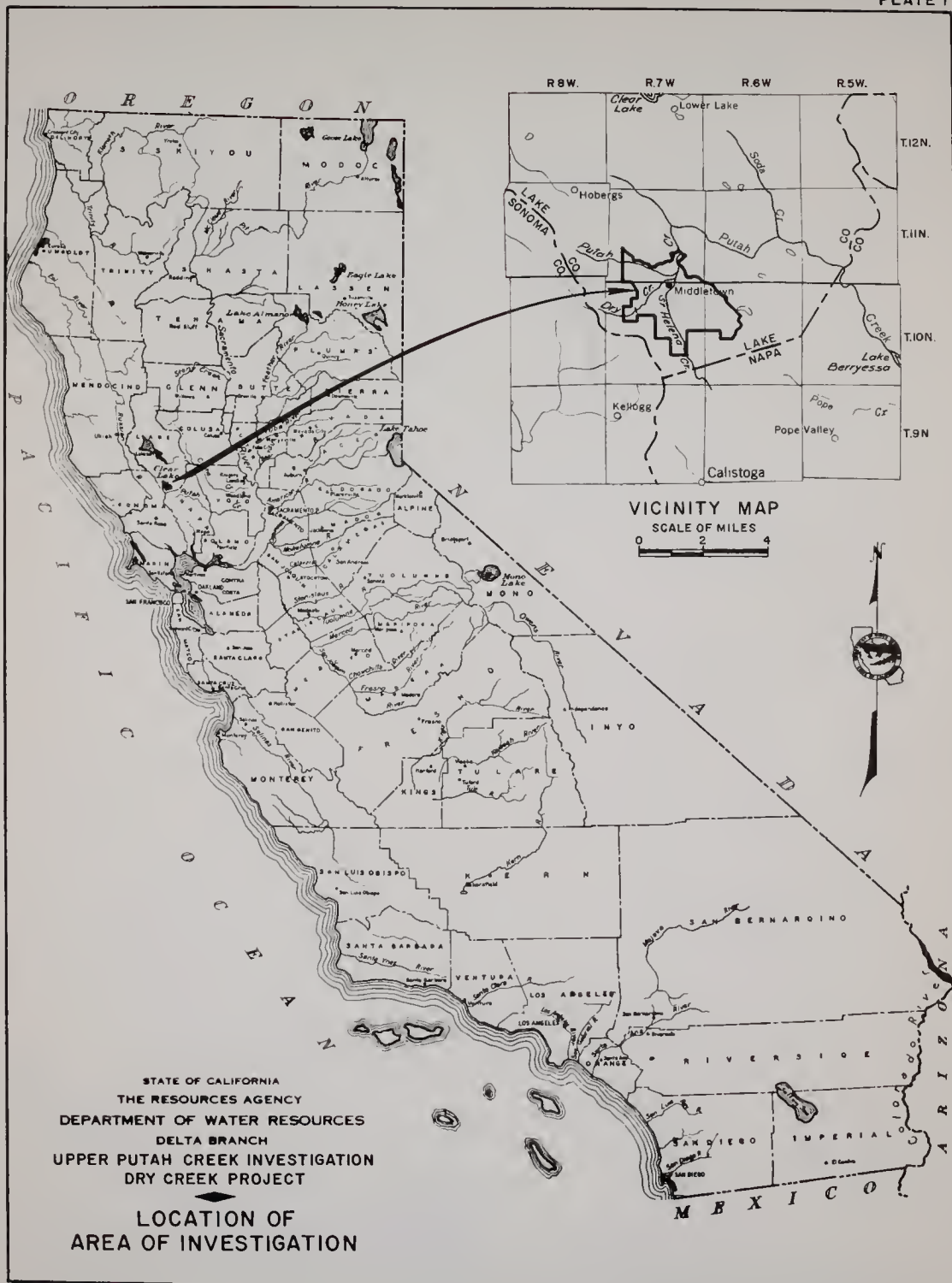


VICINITY MAP

SCALE OF MILES







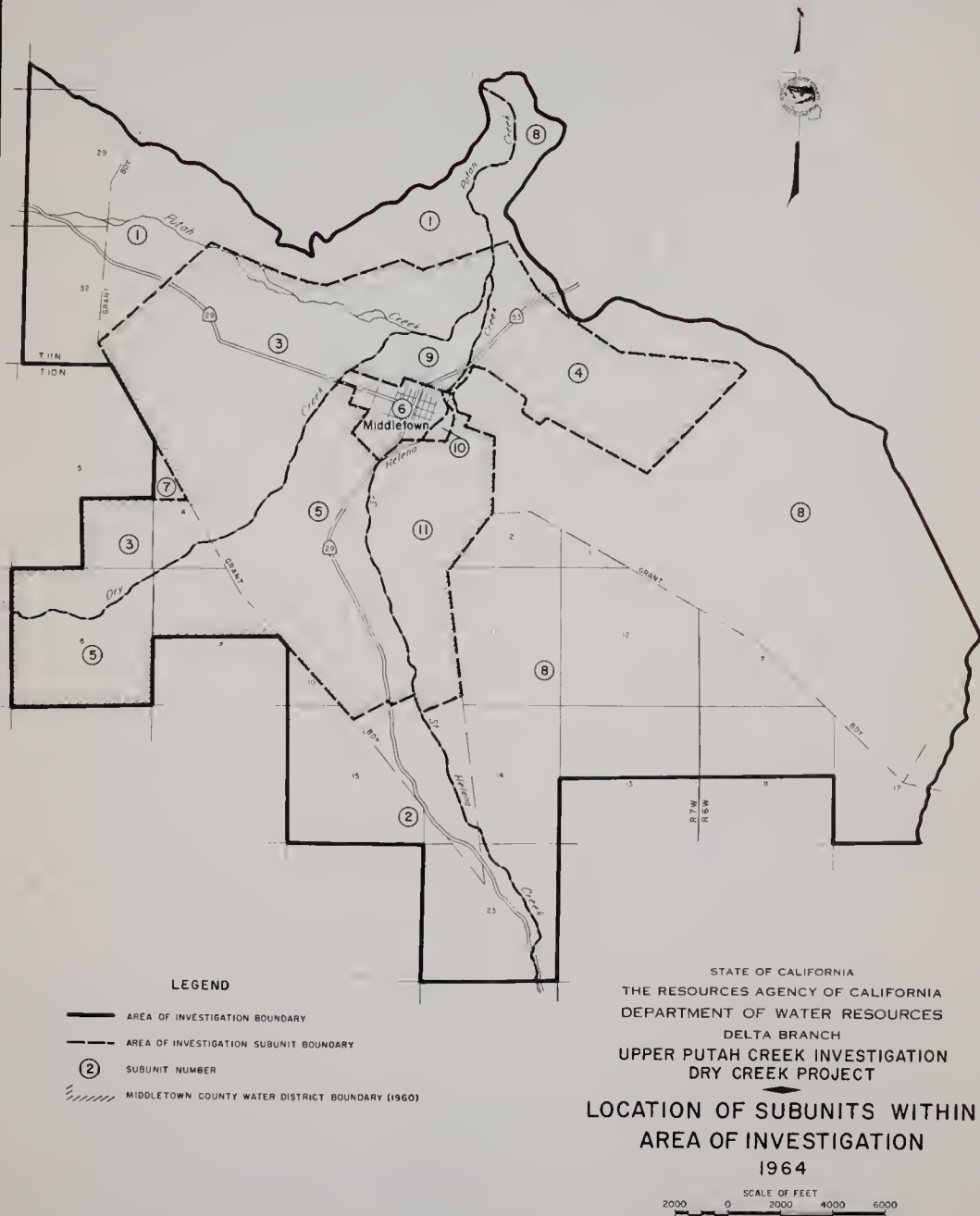


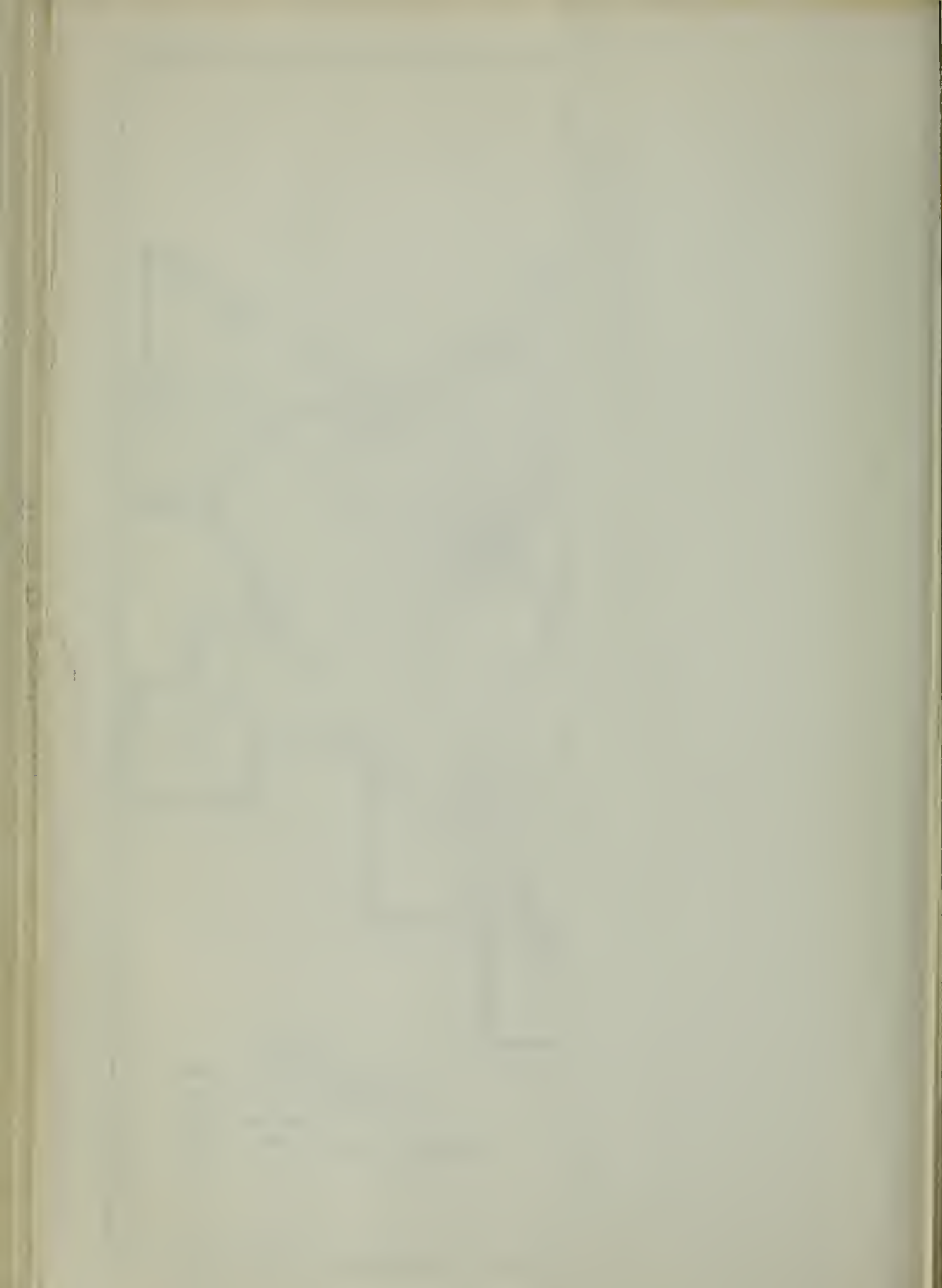


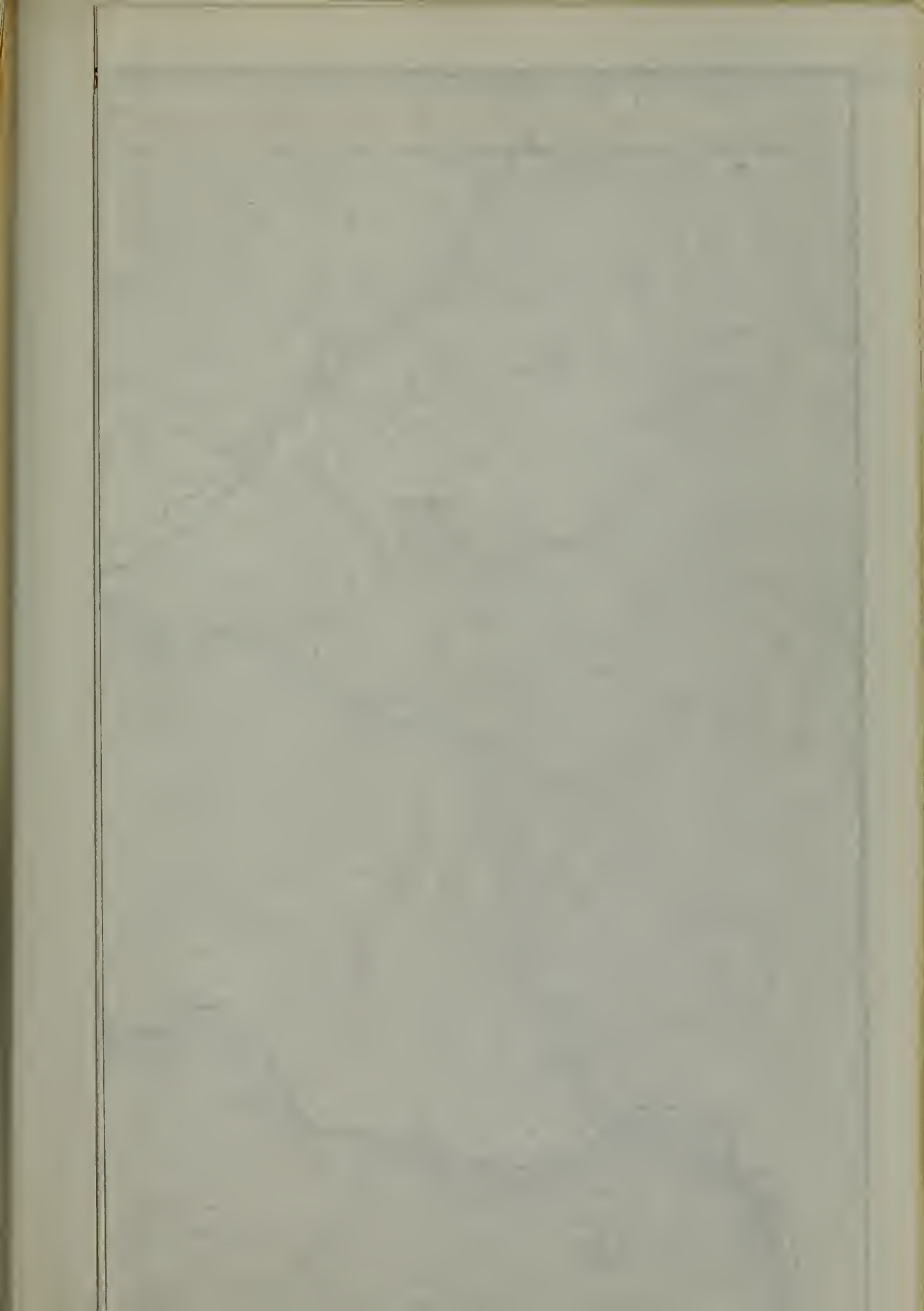
STATE OF CALIFORNIA  
 THE RESOURCES AGENCY OF CALIFORNIA  
 DEPARTMENT OF WATER RESOURCES  
 DELTA BRANCH  
 UPPER PUTAH CREEK INVESTIGATION  
 DRY CREEK PROJECT  
 LOCATION OF SUBUNITS WITHIN  
 AREA OF INVESTIGATION  
 1964

SCALE OF FEET  
 2000 0 2000 4000 6000







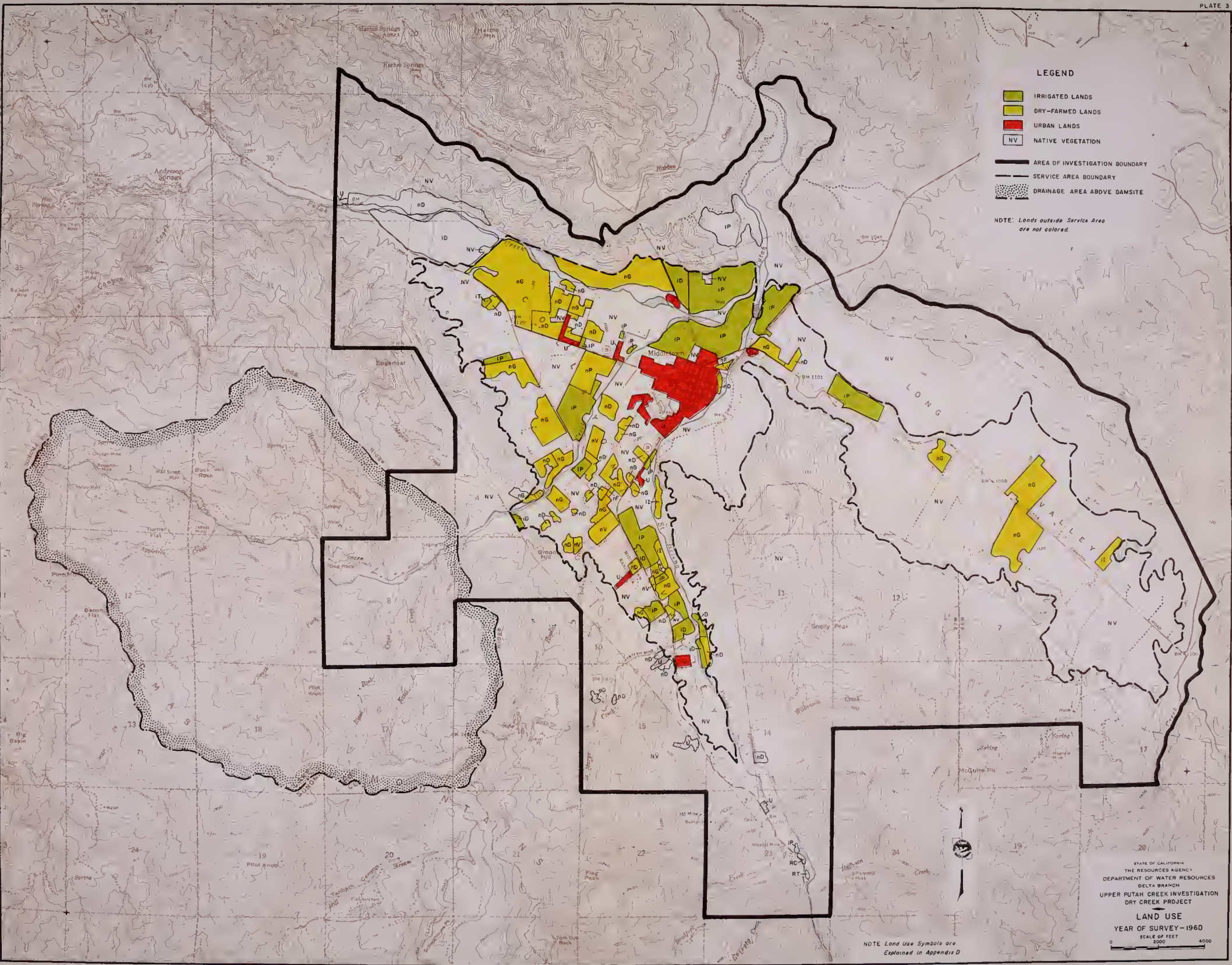




LEGEND

- IRRIGATED LANDS
- DRY-FARMED LANDS
- URBAN LANDS
- NV NATIVE VEGETATION
- AREA OF INVESTIGATION BOUNDARY
- SERVICE AREA BOUNDARY
- DRAINAGE AREA ABOVE DAMSITE

NOTE: Lands outside Service Area are not colored.

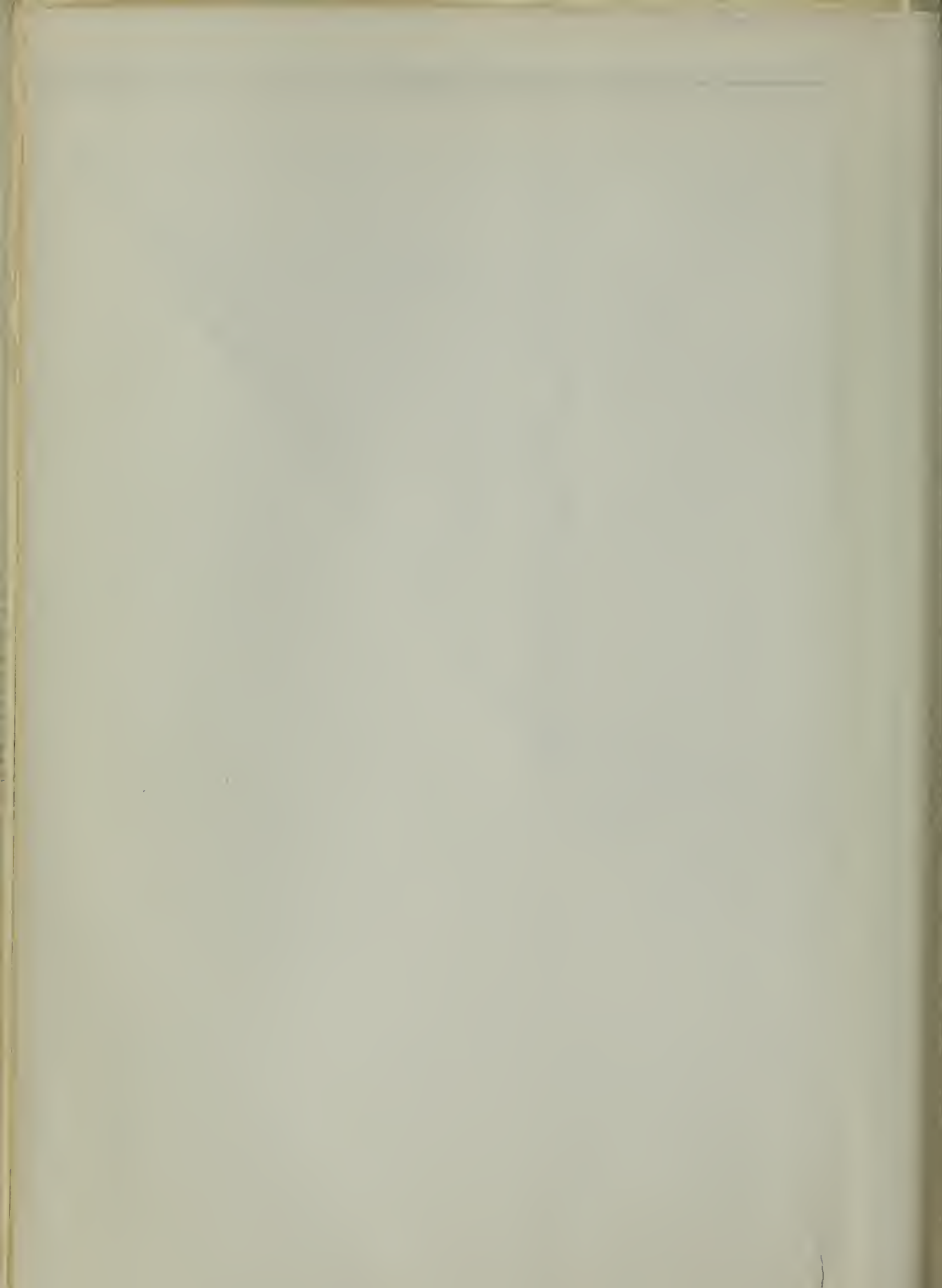


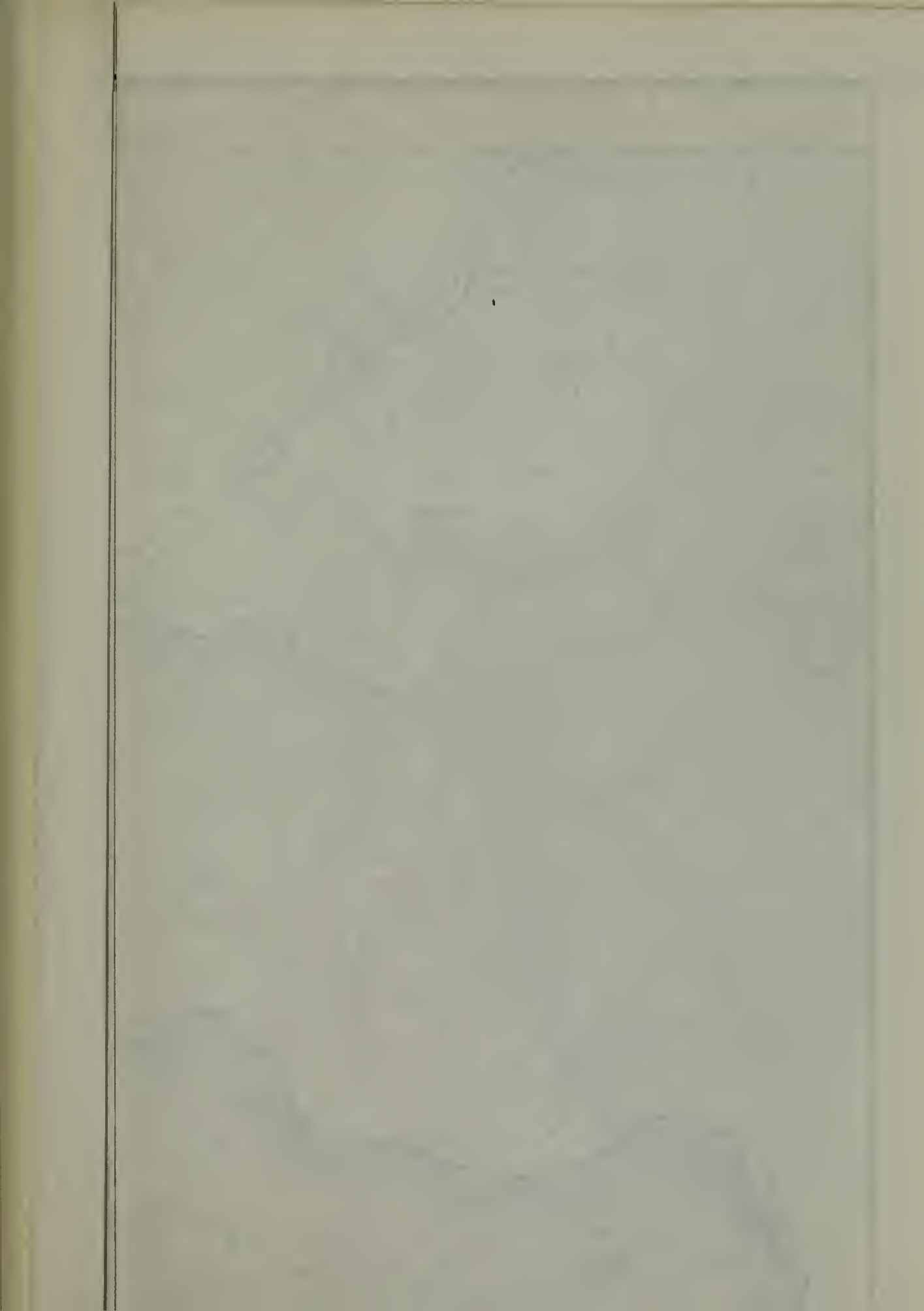
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THE RESOURCES AGENCY  
DEPARTMENT OF WATER RESOURCES  
DELTA BRANCH  
UPPER PUTAH CREEK INVESTIGATION  
DRY CREEK PROJECT

LAND USE  
YEAR OF SURVEY - 1960

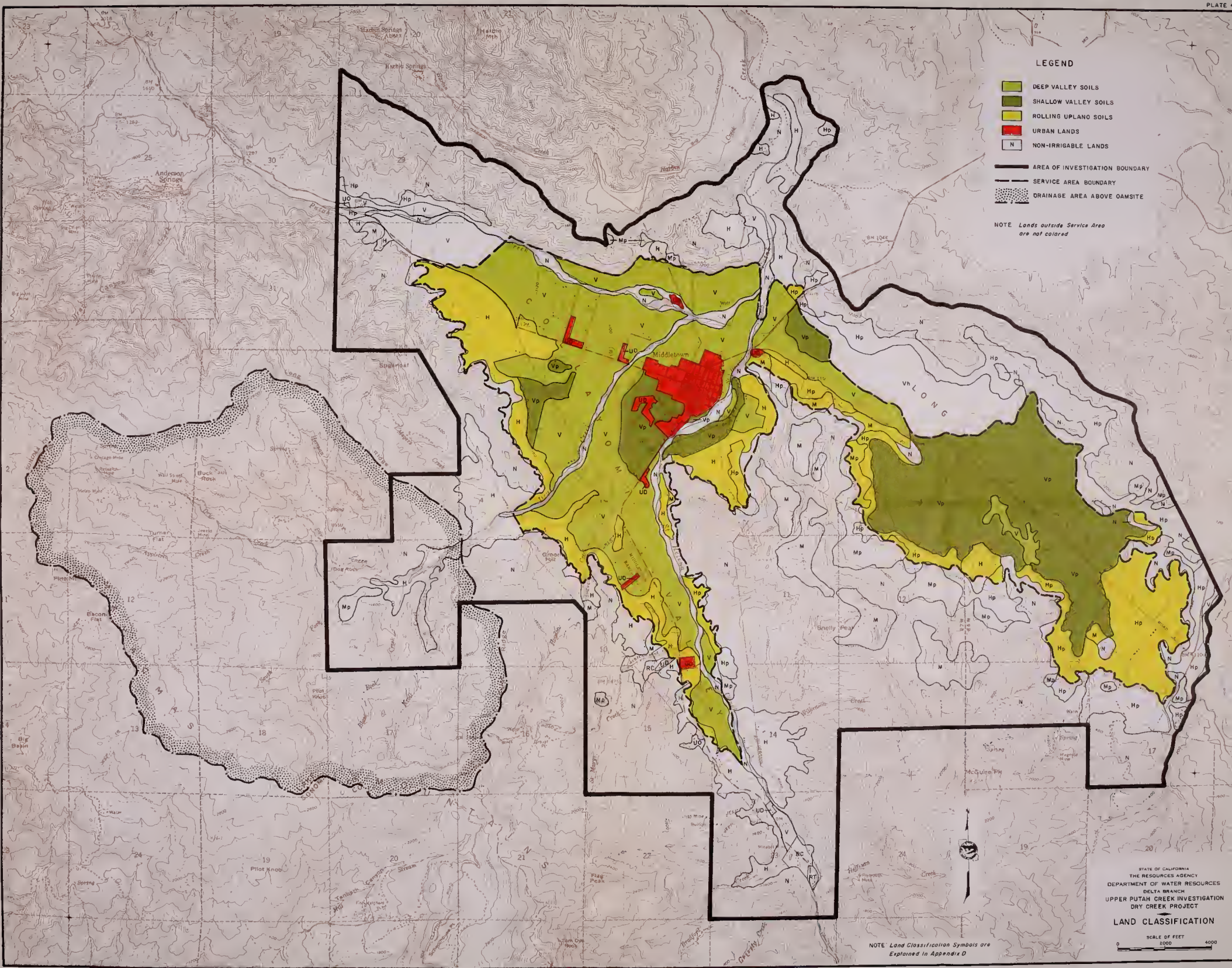
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NOTE: Land Use Symbols are Explained in Appendix D









LEGEND

- DEEP VALLEY SOILS
- SHALLOW VALLEY SOILS
- ROLLING UPLAND SOILS
- URBAN LANDS
- NON-IRRIGABLE LANDS
- AREA OF INVESTIGATION BOUNDARY
- SERVICE AREA BOUNDARY
- DRAINAGE AREA ABOVE OAMSITE

NOTE: Lands outside Service Area are not colored

STATE OF CALIFORNIA  
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DEPARTMENT OF WATER RESOURCES  
DELTA BRANCH  
UPPER PUTAH CREEK INVESTIGATION  
DRY CREEK PROJECT

LAND CLASSIFICATION

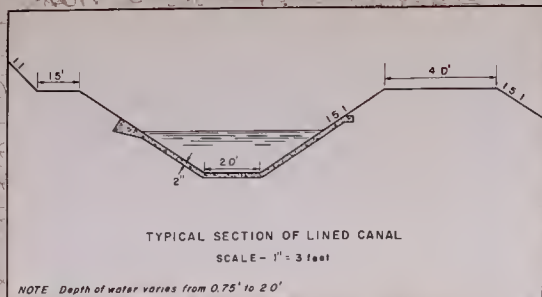
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NOTE: Land Classification Symbols are Explained in Appendix D







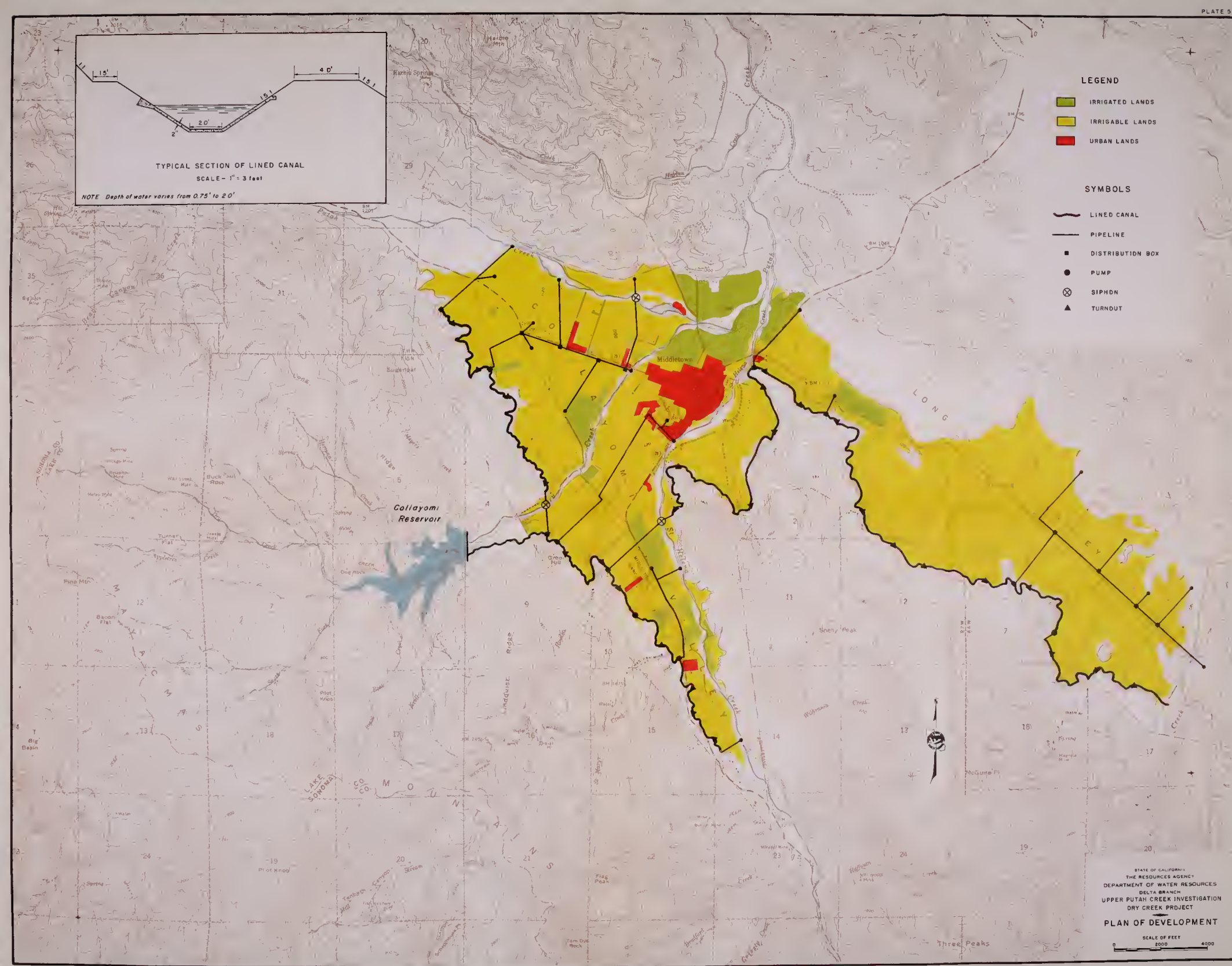


LEGEND

- IRRIGATED LANDS
- IRRIGABLE LANDS
- URBAN LANDS

SYMBOLS

- LINED CANAL
- PIPELINE
- DISTRIBUTION BOX
- PUMP
- SIPHON
- TURNOUT

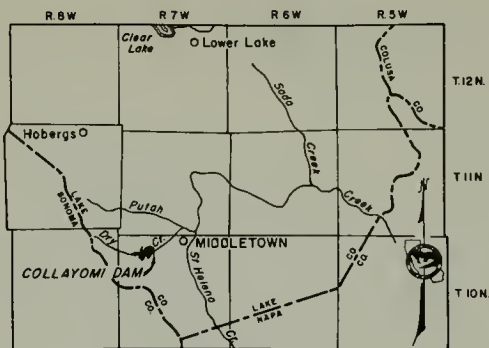
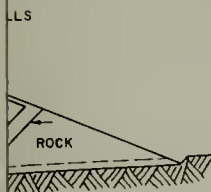


STATE OF CALIFORNIA  
THE RESOURCES AGENCY  
DEPARTMENT OF WATER RESOURCES  
DELTA BRANCH  
UPPER PUTAH CREEK INVESTIGATION  
DRY CREEK PROJECT

PLAN OF DEVELOPMENT

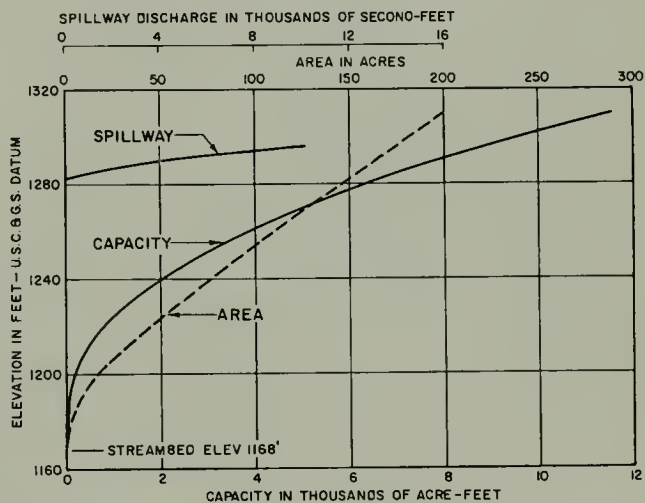
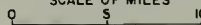
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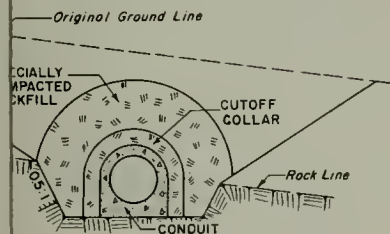


LOCATION MAP

SCALE OF MILES



AREA-CAPACITY-DISCHARGE CURVES



WORKS - TYPICAL SECTION

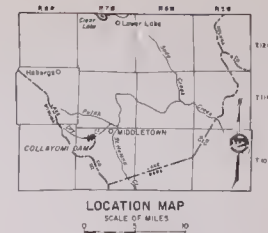
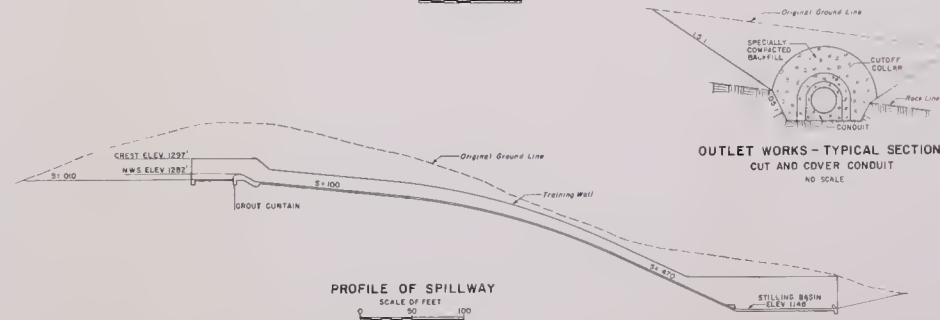
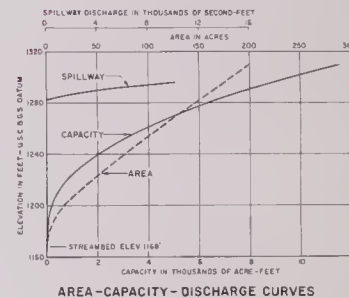
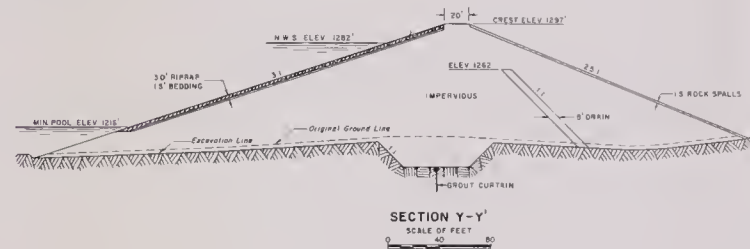
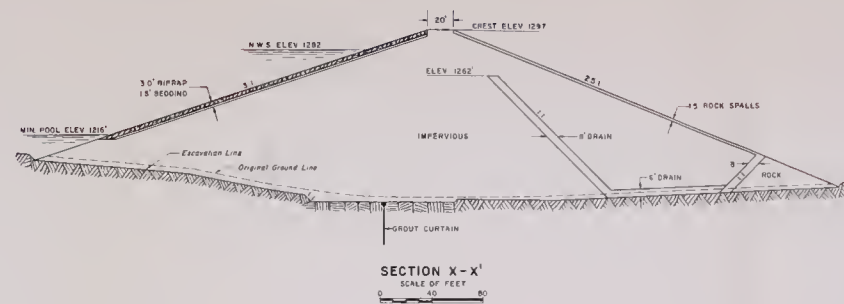
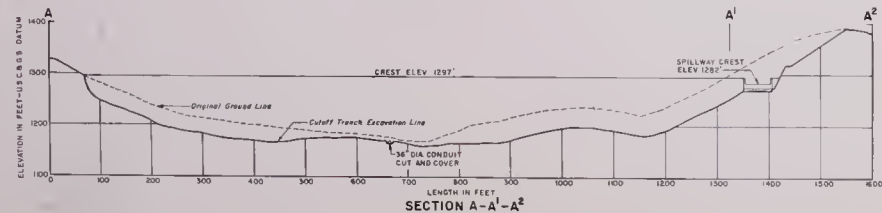
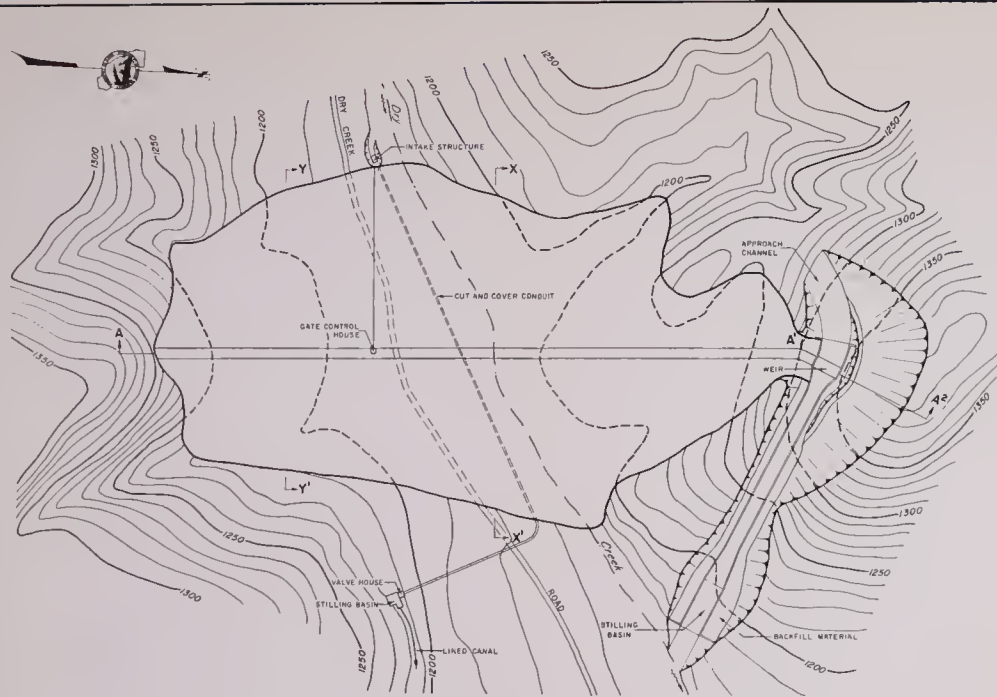
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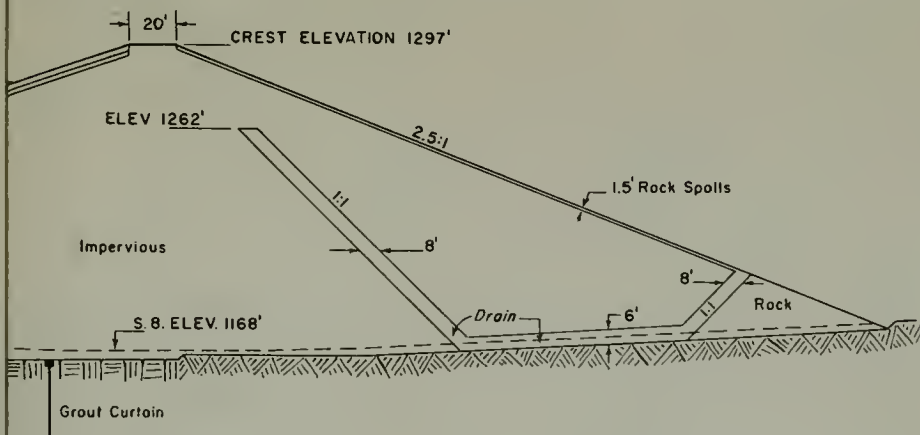
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DRY CREEK PROJECT  
COLLAYOMI DAM  
1964





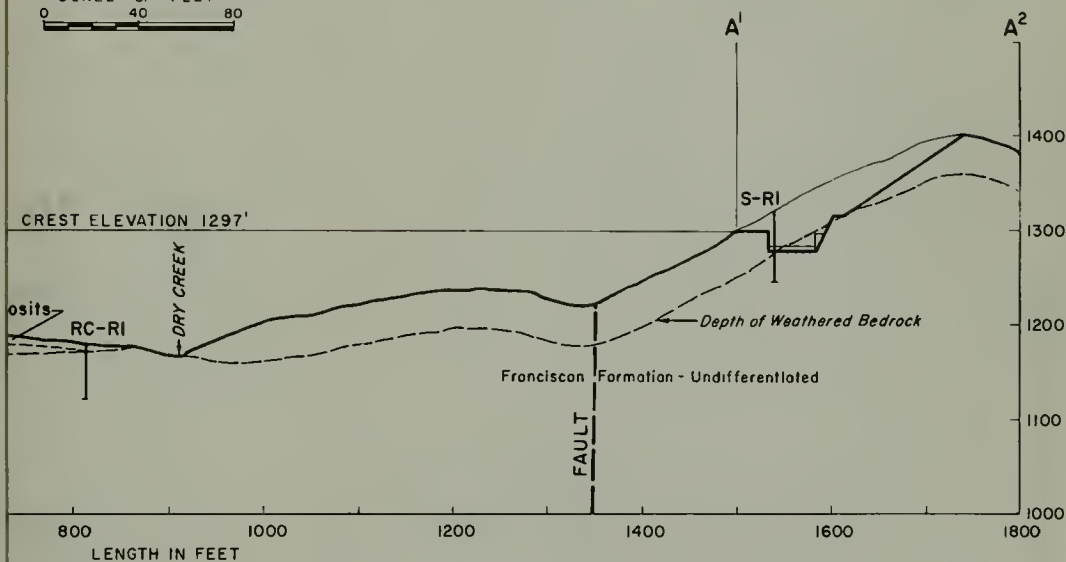
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DEPARTMENT OF WATER RESOURCES  
DELTA BRANCH  
UPPER PUTAH CREEK INVESTIGATION  
DRY CREEK PROJECT  
COLLAYOMI DAM  
1964





MAXIMUM SECTION

SCALE OF FEET  
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SECTION A-A'-A²

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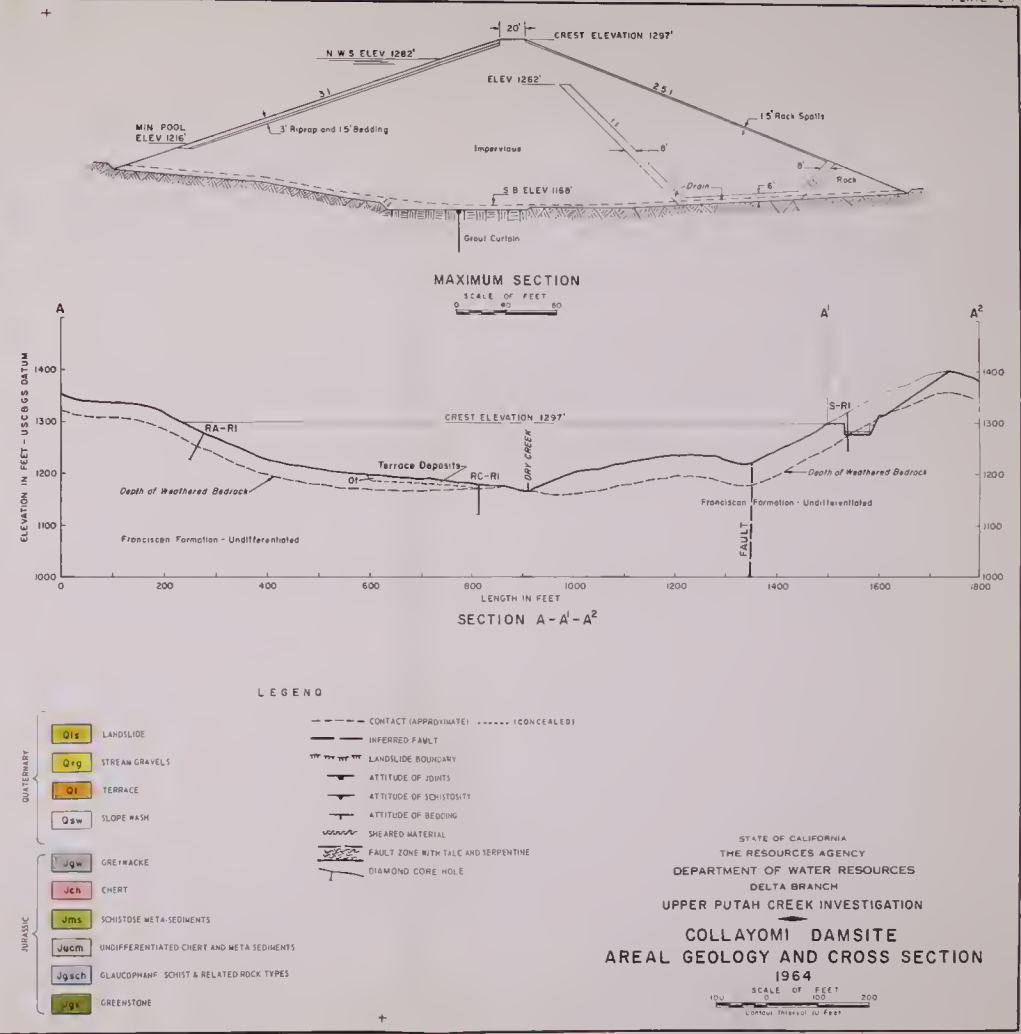
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DEPARTMENT OF WATER RESOURCES  
DELTA BRANCH  
UPPER PUTAH CREEK INVESTIGATION

COLLAYOMI DAMSITE  
AREAL GEOLOGY AND CROSS SECTION  
1964

SCALE OF FEET  
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Contour Interval 10 Feet







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### LEGEND

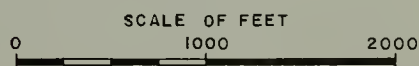
|          |   |     |  |
|----------|---|-----|--|
| RECENT   | { | Qal | ALLUVIUM-UNCONSOLIDATED STREAM DEPOSITS          |
|          |   | Qt  | ALLUVIUM-UNCONSOLIDATED STREAM TERRACE DEPOSITS  |
| JURASSIC | { | Jf  | FRANCISCAN FORMATION-LARGELY SHALE AND SANDSTONE |
|          |   | sp  | SERPENTINE-ALTERED ULTRABASIC ROCKS              |

### SYMBOLS

- GEOLOGIC CONTACT
- OUTLINE OF CONSTRUCTION MATERIALS
- 2 ● AUGER DRILL HOLE



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 DELTA BRANCH  
 UPPER PUTAH CREEK INVESTIGATION  
 LOCATION OF CONSTRUCTION  
 MATERIALS AND DRILL HOLES  
 COLLAYOMI DAMSITE  
 1964



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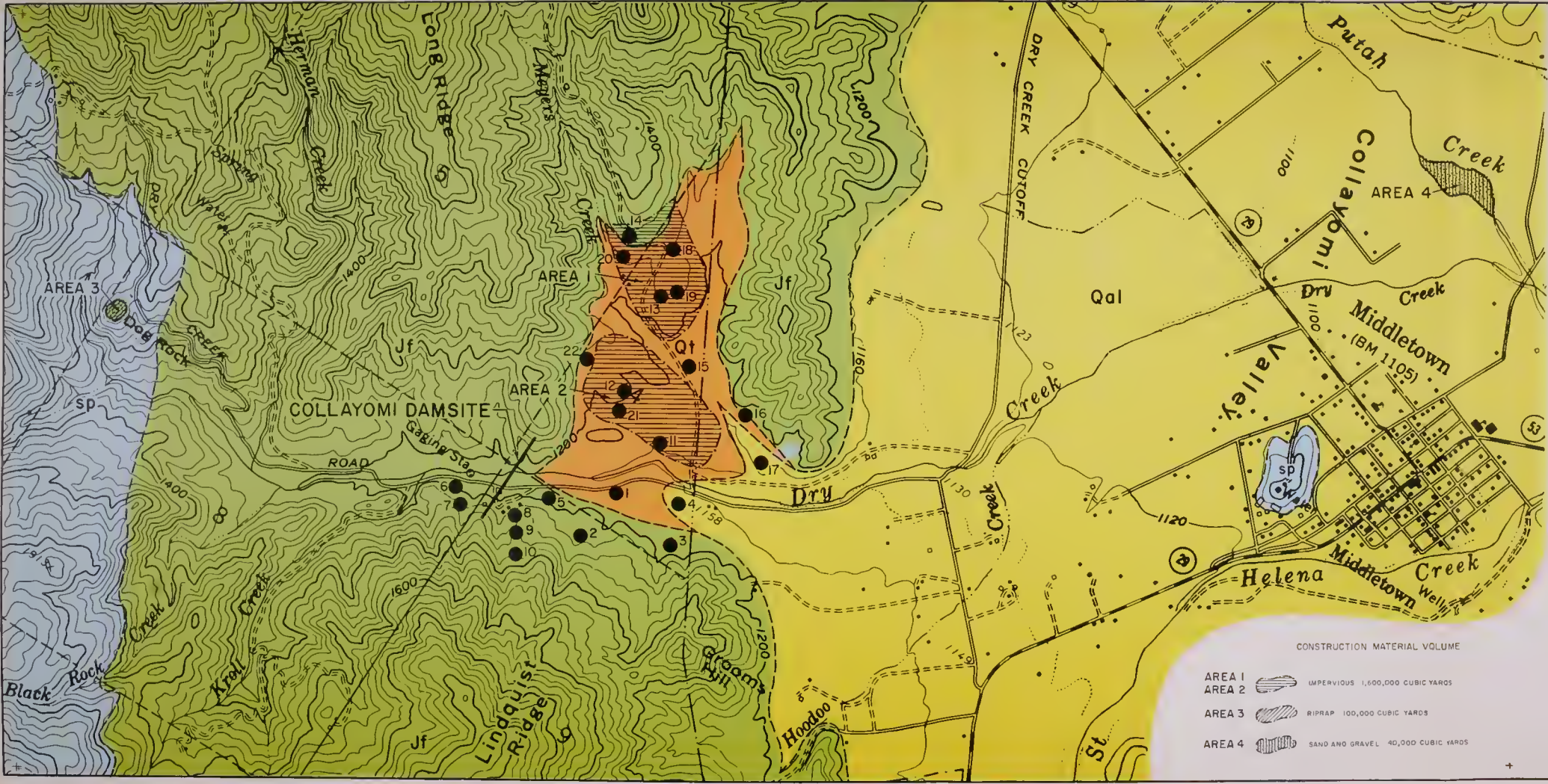
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- LEGEND
- | RECENT   | Qal | ALLUVIUM-UNCONSOLIDATED STREAM DEPOSITS          |
|----------|-----|--|
|          | Qt  | ALLUVIUM-UNCONSOLIDATED STREAM TERRACE DEPOSITS  |
| JURASSIC | Jf  | FRANCISCAN FORMATION-LARGELY SHALE AND SANDSTONE |
|          | sp  | SERPENTINE-ALTERED ULTRABASIC ROCKS              |

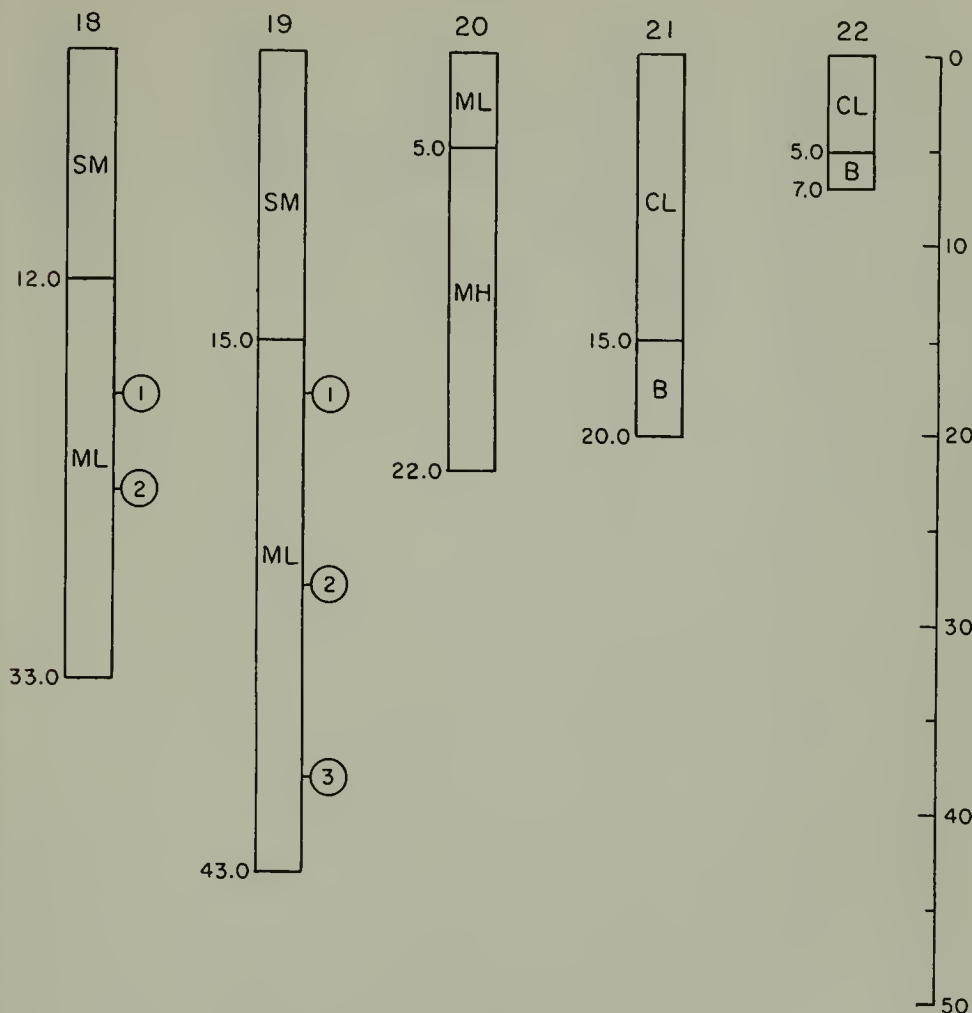
- SYMBOLS
- GEOLOGIC CONTACT
  - - - OUTLINE OF CONSTRUCTION MATERIALS
  - AUGER DRILL HOLE



- CONSTRUCTION MATERIAL VOLUME
- |        |                                    |
|--------|------------------------------------|
| AREA 1 | IMPERVIOUS 1,600,000 CUBIC YARDS   |
| AREA 2 | 100,000 CUBIC YARDS                |
| AREA 3 | 100,000 CUBIC YARDS                |
| AREA 4 | SAND AND GRAVEL 40,000 CUBIC YARDS |

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SCALE OF FEET  
0 1000 2000

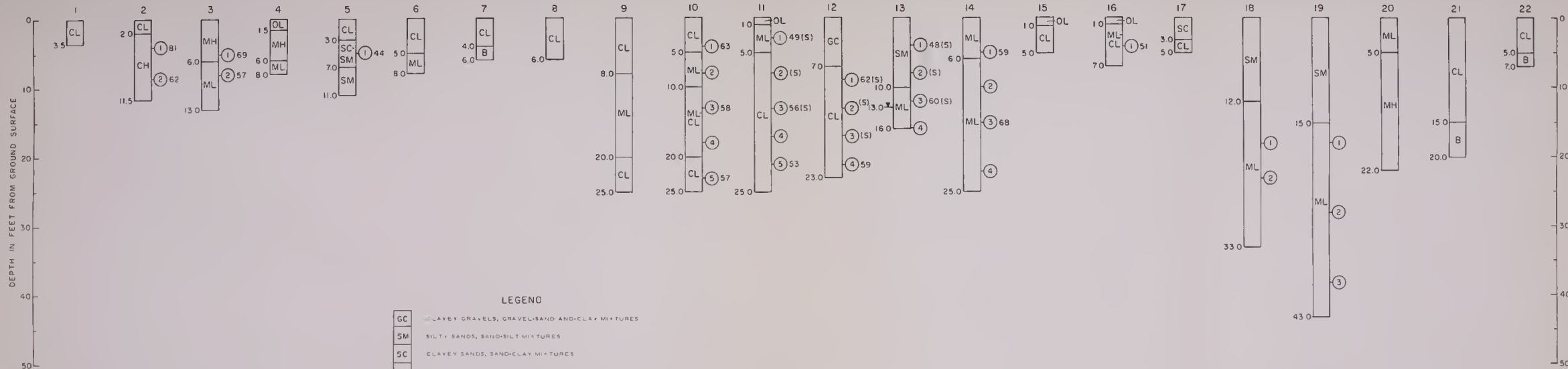




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 UPPER PUTAH CREEK INVESTIGATION

LOGS OF AUGER HOLES  
 COLLAYOMI DAMSITE  
 1964





LEGEND

|    |  |
|----|--|
| GC | GRAVELLY GRAVELS, GRAVEL-SAND AND CLAY MIXTURES  |
| SM | SILTY SANDS, SAND-SILT MIXTURES  |
| SC | CLAYEY SANDS, SAND-CLAY MIXTURES   |
| ML | INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY |
| CL | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS                  |
| OL | ORGANIC SILTS AND ORGANIC SILT-CLAYS OF LOW PLASTICITY   |
| MH | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SILTS ELASTIC SILTS                                 |
| CH | INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS  |
| B  | BEDROCK  |

- ① 81 SAMPLE NO. 1 WITH 81% BY WEIGHT PASSING NO. 200 SIEVE
- (S) SECONDARY LABORATORY TESTS PERFORMED
- ▼ GROUND WATER LEVEL

NOTES:  
1. REFER TO PLATE A FOR LOCATION OF AUGER HOLES.  
2. ALL HOLES DRILLED BY DNR 8-16 DRILL RIG.  
3. FOR LABORATORY TEST DATA REFER TO SOIL TEST SUMMARY TABLES.





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